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SCIENCE AND THE WOMAN QUESTION.

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ALMOST all social reforms are made top-heavy by a false philosophy. Facts are of easy accumulation, but the scientific rule of deducing no principle which facts will not prove gets but unwilling countenance from reform agitators. The reform philosophy which asks for the elevation of women admits an inferiority of position and power on their part, but at the same time claims that this inferiority is due to temporary causes. It bridges the broad gulf between masculine and feminine achievement by the excuse of a different environment. If the difference is, indeed, due to temporary conditions, it is, of course, removable by the removal of such conditions. It is the purpose of this paper to consider whether the difference (especially in intellectual power) of the two sexes is attributable to permanent or to temporary conditions. The nearest way of getting at this question is to attack it upon its physiological side.

Students of physiology see that a final and conclusive law can not yet be drawn from differences in brain-weights and measurements, because of the present imperfection of such data. But there is an even broader and better foundation from which to build up a conclusion, and I propose to stand on this more general ground. In order, however, that such physiological details may have due influence upon the general argument, I give a few of the best-established facts. Professor Bastian's work on the brain, published in 1880, sums up his studies of this organ as affected by sex. I condense or quote from him the following statements: "Difference of sex, in its influence over capacity of skull, is often greater than difference of race. . . . Difference of cranial capacity between the sexes increases with the development of the race, so that the male European excels much more

the female than the negro the negress. The difference in the average capacity of the skulls of male and female among modern Parisians is almost double that between the skulls of the male and female inhabitants of ancient Egypt. . . . The general superiority, in absolute weight, of the male over the female brain exists at every period of development. In new-born infants, the brain was found by Tiedemann to weigh from 14½ ounces to 15¾ ounces in the male, and from 10 ounces to 13½ ounces in the female. The maximum weight of the adult male brain, in a series of 278 cases, was 65 ounces; the minimum weight, 34 ounces. The maximum weight of the adult female brain, in a series of 191 cases, was 56 ounces; the minimum, 31 ounces. In a large proportion the male brain ranges between 46 and 53 ounces, and the female between 41 and 47 ounces. A mean average weight of 49½ ounces may be deduced for the male, and of 44 ounces for the female brain." It is further given, on the authority of Gratiolet and others, that the male brain can not fall below 37 ounces without involving idiocy; while the female may fall to 32 ounces without such a result. All accepted authorities agree that the average male brain exceeds the average female brain in weight by about ten per cent. Professor Thurnam also adds, "The brain-weight of the male negro is the same as that of the female European."

Of *qualitative* differences of brain we know next to nothing; we can not study quality from the physiological side, but are driven to an appeal to the concrete products of brain activity. Yet it is most probable that we may at some time establish an exact correspondence between brain-substance and intelligence, as the size and condition of the lungs yield an exact measure of the breathing power, and as the contractile muscle of the heart measures the quantity of blood ejected at each pulsation. In the case of every other organ of the body we know that there is an ascertainable correspondence between size and condition, and the amount of work which the organ can do. Is there any good reason for making an exception of the brain? The plethysmograph (described in "The Popular Science Monthly" for July, 1880) measures the amount of blood sent to the brain in any particular process of thought, and records the exact time for each process. We shall, doubtless, some time find it to be as complete a physical impossibility for a small and simply organized brain to do a great amount of thinking within a given time as for a small heart to eject a large quantity of blood at each beat, or for small lungs to absorb large amounts of oxygen at each inspiration. Now, if we are not yet certain of the kind and degree of structural differences in the brains of men and women, we still have overwhelming external evidence of the existence of such differences. We have as much external evidence of the superior quality of the masculine brain as of the superior breathing power of the masculine lungs, or of the superior absorbing power of the masculine stomach. We do not examine a muscle to

ascertain its internal structure. The weight which it will lift, or the distance which it will travel in a given time, is an unfailing index of its quality. If it were possible to collect all the results of the muscular activity of men, from the beginning of civilization until the present, and likewise all the results of the muscular activity of women for the same period, we should reason instantaneously, from these phenomena, to the superior quality of masculine muscle. We should need no resurrection of dead men and women to demonstrate the difference.

Let us now consider with more attention the general physiological law that quantity of power is in proportion to the size of the body. This brings us to the still more fundamental principle of the inseparability of matter and force. A large amount of matter represents more force than a small amount; and this law includes vital organisms as well as inorganic masses. Under proper conditions for test, the amount of power evolved by any vital organism is in direct ratio to the size and weight of that organism. This settles the question of *quantity* of power permanently in favor of man. The weight of all the men of civilized countries would exceed that of all the women by perhaps fifteen or twenty per cent.

Again, it is an accepted truth of modern science that all human energy is derived from the food, and is an exact equivalent of the amount of food consumed and assimilated. The amount of food assimilated by men exceeds the amount assimilated by women by about twenty per cent. This fact has popular recognition in the higher rate of board demanded for men. It inevitably follows that man, as a sex, representing more food-assimilation than woman, must represent more energy *of some kind.* If the collective weights and food-assimilating capacities of men should ever fall below those of women, there would follow a reversal of the present relations; but, while these two facts remain, it follows, with mathematical certainty, that the amount of power evolved by men must exceed that evolved by women. While man eats more, he will stand for more. It may be simply more muscle, but it must be more of something. Scientific students are rapidly coming to the conclusion that the human body is subject to the same laws of the conservation and transformation of energy which pertain to the whole material universe. Power is in direct proportion to size. The kind of power will depend upon the organization. Food converted into muscle will reappear as work; food converted into brain will reappear as thought and speech. We have a right to insist on the legitimacy of judging brain-power by brain-products. We value brains for thought as we value looms for manufacture. A barrel of brains is of no account, unless we can evolve from them a steam-engine or a poem. We have seen it hinted, in a recent essay by Dr. Bedell, of Chicago, that women probably possess a larger amount of actual nervous matter, in proportion to the

size of the body, than men. Many external facts strengthen this theory. But nervous matter distributed over the body, in the form of threads and sensory ganglia, although it would certainly increase the amount of sensitiveness, by giving more nervous surface in proportion to the entire mass, would tend to create a preponderance of emotion over thought. Very strong probability is lent to this explanation by the liability of women to nervous excitement and disease.

Before dropping the argument from physiology, I wish to refer once more to the necessary relation between size and power. Let us suppose two cases for experiment. Let them be respectively that of a man weighing one hundred and fifty pounds, and that of a woman weighing one hundred and thirty pounds. These figures are not far from the average weight of man and woman. In the woman the digestive organs will be smaller; the absorbing surface will be less; the lung-surface will be less; the quantity of blood will be less (and here we may throw in the interesting physiological fact that the solid constituents of the blood of woman are rated about eight per cent less than in man—i. e., the watery ingredient is larger in woman). Now, if we suppose these two persons to be under similar and normal conditions, with each organ bearing a harmonious relation in size to every other—i. e., if the brain of the man have the same proportion to the weight of his body as the brain of the woman to the weight of her body—it inevitably follows (if both assimilate proportionate amounts of food in a given time) that more blood will be sent to the brain of the man within a given time than to the brain of the woman in the same time. Consequently, the man will do more thinking in an hour than the woman. Nor will the woman ever be able to overtake the man in the race of thought, any more than she can overtake him in the amount of circulation; for his brain is of exactly the same *quality* as hers, but it is larger.

In order to see more clearly the importance of the factor of *time* in this calculation, as well as to get a clearer understanding of the law of the transformation of energy, let us make the further supposition that a pound of bread is gradually converted into vital energy in both these organisms. In the first place, the capacity for mastication and deglutition will be smaller in the woman. She will not be able to swallow her pound of bread in the same time as will the man. But supposing that he gave her this advantage (since it would depend on his will), yet, when the pound of bread had been transferred to the respective stomachs, the smaller lining membrane of the woman's could not secrete as much gastric juice in a given time as the man's; and as she could make no gain in time from his generosity (for the bread would have passed beyond the control of his will), she could not possibly get her bread digested and absorbed in so short a time as he. His blood could furnish the intestinal juices, reabsorb them with the food in solution, and go about some other work, while hers, with just as much work

to do and fewer hands to do it with, can not possibly keep pace with his.

If, now, we may further suppose this pound of bread converted into its equivalent of thought, it is evident that a pound of bread will represent as much thought in a woman's brain as in a man's; but, as her smaller organs refuse to assimilate as fast as his, the larger organism will have a permanent advantage over the smaller one in the element of time. Any other conclusion than the one just stated implies a contradiction of the established relations of matter and force, and there is a general historic corroboration of this idea in the actual record of sex activity. Women have done something of nearly everything that men have done, but they have come later and with smaller offerings. The time-factor is one which we are bound to include in casting up our column of probabilities for the future intellectual equality of the sexes. If our facts are reliable, and the reasoning correct, it must be admitted as proved that the factor of size has given man a superiority over woman, which he will always retain while he retains his larger body and brain. The absolute gain in time which his greater size has given him can not be set aside, unless he should cease to be the medium of transformation of energy, and should wait a few centuries for woman to overtake him, as he might have waited for her to swallow her pound of bread. But even supposing such an impossibility, and granting that she should once overtake him (in the factor of *time*), so that the two sexes could start fairly in the race of progress, the man would immediately dart ahead again by virtue of his larger size and consequently greater capacity for transforming energy. But any such supposition as an even chance for the two sexes must remain an absurdity. Unless woman can devise some means for reducing the size of man, she must be content to revolve about him in the future as in the past. She may resist her fate, and create some aberrations in her course, but she will be held to her orbit nevertheless.

The argument from physiology has still another element of strength. The perpetuation of the human species is dependent on the function of maternity, and probably twenty per cent of the energy of women between twenty and forty years of age is diverted for the maintenance of maternity and its attendant exactions. Upon the supposition that woman's mental endowment were exactly equal to man's, the amount diverted to maternity must be continually subtracted from it, so that any original equality of intellect would certainly be lost through maternity. This diversion of power would also occur in the years of highest physical vigor. This period in man is that of most active intellectual development, because the physical basis of intellectual energy is most abundant in these years. Consequently, his period of greatest intellectual gain corresponds to her period of greatest loss.

To make this position more intelligible, let us suppose the number of men and women in the world to be exactly equal. Let us further

suppose them to be of exactly the same weight; and let us add the condition of exactly the same quantity and quality of brain in both. The one sex would have exactly the same capacity for transforming energy as the other, and this would be the ideal condition of things for which the reformers plead. But, so soon as a single child is born, a certain amount of woman's energy is transformed and imparted to a new individual. The development of the individual woman holds a constantly inverse ratio to the multiplication of the species. The maintenance of intellectual equality between the sexes is impossible, because it is only supposable by the creation of impossible conditions. If our original men and women, who were in all respects equal, had no offspring, the equality would continue for a generation, until the species should have disappeared with the death of the last of these hypothetical beings.

By reflecting that no such original equality ever existed, but that, on the contrary, a considerable physical superiority has been the possession of man from the beginning; by remembering that, in the perpetual struggle for existence, man's physical and intellectual faculties have been stimulated to the utmost in gaining the means of life for himself and for his weaker mate and offspring; and by considering how large an amount of woman's energy must be diverted from intellectual pursuits to the function of maternity—we see that the conditions of intellectual development are vastly in man's favor. We also see that the main features of these original conditions are permanent conditions of human life on the earth. Woman's inferior size and power will forbid her becoming the successful rival of man in the struggle for existence. Consequently, she will miss the powerful intellectual stimulus which this competition creates among men. Lastly, while society continues to exist, she will always be obliged to expend a large proportion of her energy in the function of maternity. All these enumerated and inevitable facts bear upon her chances of intellectual growth, and have a tendency to widen the intellectual gulf between herself and man. Mr. Darwin, in his "Descent of Man" (vol. ii, p. 313), after enumerating the causes which strengthened the differences in mental power of the sexes, adds, "It is, indeed, fortunate that the law of the equal transmission of characters to both sexes has commonly prevailed throughout the whole class of mammals; otherwise, it is probable that man would have become as superior in mental endowment to woman as the peacock is in ornamental plumage to the peahen."

It is not unlikely that the still imperfectly known laws of heredity have increased the intellectual endowment of the male, for Mr. Darwin finds a general law of transmission in the line of sex. If, too, we accept Mr. Spencer's proof of the inverse ratio between individuation and multiplication, we see that intellectual mothers will have fewer daughters than unintellectual ones; so that the chances of transmission

of intellectual qualities in the female line will be lessened as culture increases among mothers. Accordingly, the intellectual tendencies which might have been acquired by the short and easy method of heredity will have to be acquired by the slower processes of application. This, again, will require the expenditure of a proportionately larger amount of energy in women than in men, supposing that men have a higher average of intellect through heredity. Moreover, the probabilities of marriage, or, at least, of early marriage, are lessened in cases of intellectual women; so that the chances are, not only that intellectual women will have few daughters, and so be unable to add to the general average of female intellect by sex-transmission, but also that they will be unable to add anything whatever to the sum of hereditary intellect in either sex.

Man has two powerful advantages over woman: the admitted superiority in the size and weight of body and brain, and the certainty of the continuance of conditions which insure that superiority, for the conditions of masculine superiority are the very ones upon which the preservation of the species depends. The necessary outcome of an absolute intellectual equality of the sexes would be the extinction of the human race. For, if all food were converted into thought in both men and women, no food whatever could be appropriated to the reproduction of the species. But, as an actual fact, women do not consume so much food as men; nor can they do so while their average size remains so much smaller. Moreover, of this smaller amount of food consumed by women some must always be spared for the continuance of the race; so that the sum total of food converted into thought by women can never equal the sum total of food converted into thought by men. It follows, therefore, that *men will always think more than women.*

Nevertheless, if it could be shown that the energy derived from food in men were an energy of inferior *quality*, women might gain a compensating factor in quality of thought. By the consent of competent judges, the reasoning power and the creative imagination are the highest and most complex forms of brain-energy. We have the most abundant evidence that, while man possesses both these powers in large amount and of superior quality, woman possesses them in much smaller amount and of inferior quality; so that the distinction of exceptional women, of whom a list could be made, would add little to the general low average of feminine power. We hear the power of *intuition* quoted as a higher one than reason. Women possess this power in a higher degree than men, and are sometimes rated above them in consequence of it. Very little study has been bestowed on this faculty, which has been the occasion of so much self-congratulation to women. But there is considerable evidence that it is acquired by heredity, that it is closely akin to instinct, and that some modification of it is the common possession of women, children, and the lower animals. It is possessed in

a lower degree by men, but has escaped registration as a masculine trait. In his classification of the mental powers of the two sexes, Mr. Darwin puts observation, reason, imagination, and invention as those especially selected in man, and likeliest to be transmitted to male offspring. He also says: "It is generally admitted that with woman the powers of intuition, of rapid perception, and perhaps of imitation, are more strongly marked than in man; but some, at least, of these faculties are characteristic of the lower races, and therefore of a past and lower state of civilization."

MUSCULAR EXPRESSION OF NERVOUS CONDITIONS.*

By Dr. FRANCIS WARNER.

COARSE or extensive paralyses, such as involve one or both sides of the body, and other profound disturbances of the muscular system, have received much attention from clinical and pathological observers, and by the accumulation of their joint observations much knowledge has been gained as to the symptoms that result from lesions of the brain. This should encourage us to observe in all cases the conditions of the muscles, knowing that the movements correspond to certain states of the moto-centers, and looking upon such nerve-conditions as indications or expressions of the states of those centers. All expression of feeling is effected by muscular action, whether it be by words, by facial movement or gesture, movements effected by voluntary muscles; or expression may be produced by dilatation of the pupil, erection of the hair, or disturbed action of the heart, these being due to the conditions of inorganic muscular fibers. I have been accustomed to regard the nerve-muscular condition of "nervous cases," when seeking definite signs by which to describe them, in the light of the principle that movements depend upon nerve-muscular stimuli originating in nerve-centers. Examples may easily be given, showing how we commonly judge of the state of the nervous system by muscular conditions. Note the stooping attitude and spiritless gait of a tired man as compared with that of the same individual when rested and refreshed. Incipient intoxication is indicated by a reeling gait, unsteady hand, and muscular tremor. Expression may be indicated by the position of the head, which is seen firmly upright in defiance, drooping in shame; is commonly held on one side in nervous women and girls convalescent from chorea, the first example cited of an asymmetrical gesture. The artist's brush or pencil, the sculptor's modeling-tool and chisel, the pianist's and violinist's finger-touch, indicate the training

* Abstract of articles published in "Brain."

and actual condition of the working of his brain. The educated and refined singer trains and refines his whole mind, i. e., his brain, and is well aware that his "whole soul," as he may express it, comes out in the action of the muscles concerned in producing his song and musical notes. In the infant the condition of the nervous system is best recorded in terms of nerve-muscular phenomena. It laughs, and is playful; reflex action is well marked when a finger is placed in the child's mouth. The eyes are moved and directed toward any object looked at; these are conditions of healthy action. It is well known that in the convulsive state the fists are often closed, with the thumbs turned in. All these examples of expression are nerve-muscular conditions; the movement, the attitude, the gait, result from states of the brain or spinal cord.

The normal movements of the eye are seen in the varying conditions of the pupil under the influence of light, in the changes accompanying accommodation for near and distant vision, and in the turning of the eyes in any given direction, a movement in which the parallelism of the axes of the organs is usually maintained. Each of these movements is supposed to be governed by a particular brain-center; and the convergence of the lines of the axis which takes place when the eyes are called upon to look at some very near object involves a complicated association of muscular conditions. The associated movements of the eyes may be completely lost in deep anæsthesia from chloroform, in coma from alcoholism, or in the profound sleep of infants. If, in an adult deeply under the influence of chloroform, the eyelids be gently raised, the pupils will be seen minutely contracted, often to a pin-point, the eyes having at the same time lost the parallelism of their axes. One eye may move upward or outward, while the other remains quiet, or moves in a different direction or at a different pace, thus causing a temporary and varying strabismus. Usually these movements are confined to the horizontal plane; less commonly the eyes assume a different level, one being in the horizontal plane while the other is turned downward. In these cases the co-ordination of the movements is restored with returning consciousness.

Loss of associated movements may sometimes be easily detected in very weakly infants while awake and sucking at the bottle, and in cases of meningitis and other conditions of coarse brain-disease; and sometimes appears to be chronic in paralyzed or partly paralyzed and idiotic persons. Many of the lower animals have the power of moving either eye separately and independently, a fact which leads to the suggestion that the brain-center that co-ordinates the movements of the two eyes may be looked upon as one more recently developed in the ascent of man.

In nystagmus, a disease in which the eyeballs oscillate rapidly, usually in an horizontal, rarely in a vertical direction, the parallelism of the axes is generally maintained. In one recorded case, the eyes were capa-

ble of being turned slightly to the right, not at all to the left; yet, when an object on which the eyes were fixed at a distance was gradually brought close to the face, the eyes converged upon it, the right eye moving about fifteen degrees to the left to bring the line of its axis upon the object. Such an affection may be accounted for on Ferrier's theory by supposing that one of the brain-centers controlling the horizontal movements of the eyes had been destroyed. Most of the ordinary movements of the eyes in health are probably horizontal, and are least voluntary; and because they are very simple, and do not involve movements of the muscles of the eye, they are regarded as the least intellectual. The vertical movements are more complex, calling special muscles into play, and may, therefore, be considered more intellectual. From direct observation, it appears to me that intellectuality is represented by the movements of the eyeballs in their orbits. When an individual in looking at an object moves the eyes by the action of the recti muscles so as to direct them towards it, the movement is more intellectual than when the head is turned so as to direct the eyes in the required direction. A bright, healthy, well-developed infant turns its eyes well in the orbits in looking about; not so a dull, wasted child. Again, intellectual people usually move the eyes in their orbits in looking at any object; the low and vulgar often move the head in the direction required. The movements of the face, like the other forms of expression by muscular action, are generally symmetrical. Asymmetry is, however, seen in facial palsy, in sneering, and occasionally in the one-sided grimaces of very nervous people. Certain commonly marked lines in the face—horizontal and vertical lines in the frontal zone, the naso-labial grooves, the lines of the upper and lower lips, and the positions of the angles of the mouth—exist as the result of the puckerings produced by muscular action. Among the facial muscles, intellectuality appears to be most commonly expressed in the frontal and middle zones, and by the action of the corrugator and orbicularis-oculi muscles. It has been possible among out-patients to accept the facial appearance as a physical sign of mental as well as of physical and organic suffering. In cases where the muscular expression has been marked, some painful condition and some source of anxiety or mental distress has almost invariably been found. A person suffering from headache, or who "looks as if he had a headache," presents an appearance of depression, heaviness, fullness about the eyes, especially about the under eyelid; the orbicular muscle and adjacent parts are flabby, with the skin hanging loosely. If the patient can be induced to laugh, the muscle recovers its tone, the skin is tucked well in against the eyeball, and the appearance of depression or expression of headache is lost for a time. The life of the eyes is given, not by the eyeball, which is almost wholly lacking in expression, but by the conditions of the eyelids and of the muscles that move them, and in some degree by the muscles which

move the eyeballs. The action of the muscles about the angles of the mouth is affected by a very moderate amount of brain disturbance. The value of the study of the nerve-muscular conditions of the face is finely illustrated in the case of the passive, expressionless face which may be woke up, "lighted up," made to express the whole soul in the face simply by conditions of the tension of the facial muscles resulting from the mental state. Thus, often, great and pleasing beauty is seen in faces unattractive when at rest. Conversely, some faces are beautiful in their passive condition, but lack expression and interest when in action from mental work; women having such faces talk but little. Surely from these two conditions it is suggested that the passive form and color of a face are qualities not so great, not so mind-indicating, as the mobile expressions produced by muscular tension.

Probably the most expressive of the muscles of the upper extremity are those that move the fingers, or which produce the "finer movements," motions in small arcs, as distinguished from the "coarser movements," or those that are made from the shoulder or the elbow. It is, of course, in the free or disengaged hand that we must look for examples illustrating the condition of the brain which governs it. If the muscles be employed in some definite act, such as holding an object, or in an act of manipulation, such as sewing, then the movements are directed to accomplish the aim attempted, and are not simply indicative of the condition of the brain, as may be the case with the free hand when unconsciously expressing the mental condition by gesticulation. When, on the contrary, the hands are left free and disengaged, as the hand of the orator, which unconsciously expresses by its position or movement the general mental state of the speaker, we have in this muscular movement an expression of the man's mind. It is as unreasonable to look for the state of the mind to be expressed in the position and action of the hand engaged in definite, voluntary, purposive acts, as to look in the face when the sun is shining full in the eyes, or the lips are engaged in eating, or other movements affecting the regularity of the breathing. Still it is true that in either case the manner of performing the act may be indicative of the mental state, but the muscles of the face or hand are not engaged in expressing the mental state.

In art of the present day we but seldom see the hands represented as disengaged; usually they are painted or sculptured holding some object, or resting on some part of the figure; such are hands engaged or resting from labor, or performing some act of toil, not engaged in expressing some action of the mind.

When a very nervous child, or one convalescent from chorea, holds out its hands in front on a level with the shoulder, and with its fingers spread out, we commonly see the nervous hand. As the palms are turned down, the wrist droops slightly. The metacarpo-phalangeal joints are moderately extended, the first and second internodes being

either flexed or kept straight. The thumb is simply extended backward, and somewhat abducted from the fingers; and a twitching of the fingers is frequently observed.

The energetic or powerful hand is the reverse of this, and is probably seen in life only under certain conditions of the mind, producing what we call "mental states," or states giving energy and the feeling of strength.

The most natural position of the hand is that of rest, and here analysis shows all the joints in flexion. The hand may be seen in perfect rest during sleep, or when the man is resting, engaged in quiet, unexciting conversation.

The antithesis of this is a hand in general extension or ortho-extension. The term ortho-extension is used to imply that the joint is so far extended as to place both the bones constituting the joint in the same straight line. If extension be full or complete, the bones form an obtuse angle with each other.

In the "ortho-extended hand," the axes of the metacarpal bones (hand-bones) and of the digits are in the same plane with the bones of the fore-arm, and the position is represented in which a strong man naturally holds out his hand when requested to put it forward. A healthy child, when it runs in its play or to meet a friend, commonly holds out its arms, the hands assuming the "energetic position"; and this, as the result of observation, is, I think, characteristic of a healthy, nerve-muscular condition; healthful children in pictures by the best masters are often thus represented. When a child is in a state of convulsion it is well known that usually the hand is closed, with the thumb turned in upon the palm, the fingers being flexed around it. Such a position of the hand in a child when ill is very indicative of a state of the nervous system predisposed to convulsions.

Equally characteristic with the passive positions of the hands are the muscular movements of the fingers—twitching, tremors, and rhythmical movements. These conditions have been more fully studied and described than the characteristic passive positions (postures), and they have long been considered as visible muscular conditions expressive of the states of the nerve-centers. The varieties of finger-twitching may be described as—1. *Flexor-extensor*, the primary movement being that of flexion, followed by a secondary extension movement. This may be seen in a variety of cases, and in particular is seen in what is called "picking the bedclothes" in the typhoid state preceding fully developed coma. 2. *Extensor-flexor*, the primary movement being that of extension, followed by a secondary flexor movement. This is common in the slighter forms of chorea and in nervous children; such twitches usually constitute the *subsultus tendinum* so indicative of exhaustion in the course of typhoid fever. 3. *Abductor-adductor* twitches, the movements consisting in lateral separations of the fingers, followed by their being drawn together again.

The movements of the head—aside from those due to movements of the cervical spine—may be classified as those of flexion and extension; the bending forward and backward of the head; of rotation, in which the head remains erect; and of inclination or the depression of one or the other side. Flexion and extension of the head are of frequent necessity and physiological import; rotation is frequently necessary to move the eyes toward an object looked at, or to direct the ear toward a source of sound. Inclination is, I think, often of other significance: it sometimes indicates weakness, it is more frequently seen in young girls and weakly persons than in strong men. Inclination, with rotation to the same side, with slight flexion, is a position of the head very commonly seen in choreic girls, and then often accompanies an awkward, ill-balanced position of the spine. Inclination of the head, with rotation to the opposite side, and slight extension, is indicated by Sir Charles Bell in his figure in "Adoration." In seeking general information as to the signs of cerebral adequacy in an infant—that is, whether the infant has a good sound brain, probably capable of development—we always notice whether it can hold its head up, whether it usually keeps its head erect while sitting up.

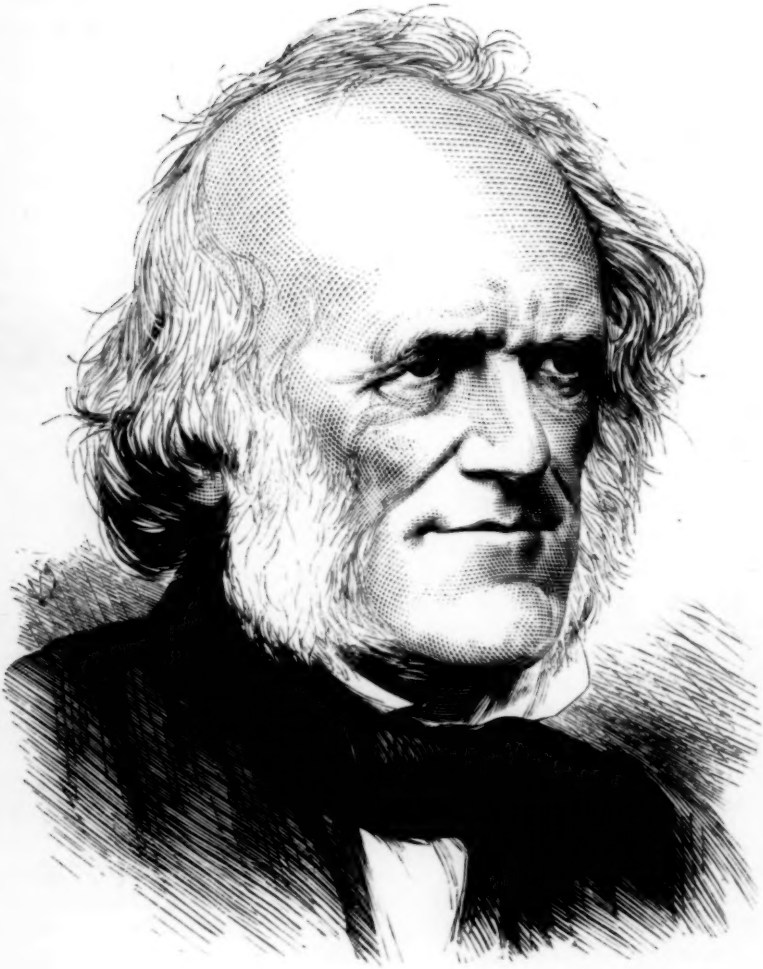
Tooth-grinding, which is common in nervous children and among lunatics, champing of the jaws, and trismus, are signs of disordered conditions of the fifth nerve. The violent motions of the tongue seen in chorea and whooping-cough, the tremulous tongue of alcoholism and paralyses, indicate affections of the seventh nerve. Affections of the pneumogastric may produce palpitations, irregularities of organic action, the bronchial spasm of asthma, and functional aphasia.

It is a matter of very common experience that children and adult patients "hold themselves awkwardly"; stoop, or otherwise give the spine and trunk an ill-balanced position, due to want of nerve-muscular energy, and characteristic of the condition of exhaustion and weakness. Doubtless there is much expression in a torso; in many cases a weakly condition is indicated by a stooping attitude, with a lolling over to one side. It is difficult to indicate in precise terms the positions and movements of the spine, and perhaps this is one reason why so little is known about the action of the muscles of the back. With regard to the lower extremities, the gait and manner in walking may be characteristic of brain or cord disease. Conditions affecting the muscles of both lower extremities are usually dependent upon disease of the cord, and most of the signs by which spinal disease may be localized are derived from examination of the muscles of the legs. Reflex actions are also used as a means of localizing and ascertaining the condition of the nerve-centers, and here, again, visible muscular conditions are the indices.

The significance of the action of muscles as indicating brain conditions has long been dwelt upon by writers. Camper, who wrote in 1821, has shown that the Laocoön presents evidence of how deeply the

ancients had investigated the influence of pain as expressed in the figure and the muscles. Further on he quotes from the words of Paulo Somazzo's work, "Dell' Arte della Pittura," published in 1531, a passage describing the influence of the passions upon the muscles of the face, and still more minutely the different postures and contortions of the body. John Bulner, in his work entitled "Significative Muscles of the Affections of the Mind," published in 1649, expressed the opinion that every motion of the mind is indicated by a corresponding motion of the muscles, saying: "When we assent, affirme, yield, grant, vote, confirme, confesse, admit, allow, or approve of a thing, etc., we are wont to nod or bend our head forward, the naturall reason of which motion in these, seems an approving, which is made by the Imagination, seeing, or hearing, somewhat done or said which accordeth very well, and this power remaineth in the Braine or forehead part of the head where in the cell and Seat of the Imaginations lieth. When any of these things give it contentment, suddenly it moveth the same, and after it all the muscles of the body."

There is in the subject before us a field for observation and description in which the artist and the physician may work together, observing and analyzing, with as much exactness as may be, the mode by which the varying conditions of the brain and mind are indicated to our eye, and may therefore be described by words, and by drawing or sculpture. We must study man in all aspects of the case, and when we see in the face, limbs, or body indications of his brain or mental condition, we should analyze and describe—first, the position of features and parts as we see them, then the muscles which produce those positions or movements, knowing that the muscular condition which has produced the movements or positions is the result of the state of the corresponding nerve-centers. It has been said that a man's face is an index of his mind, and this is true; for all the varying changes of expression in the face (except those of color) are due to changes in the facial muscles, and these solely depend upon changes in nerve-cells. The knowledge that we already possess of the nerve-centers is from observation of the condition of the muscles. In a given case, by comparing the state of the muscles during life as they may be affected with paralysis or spasm with the brain-lesion found after death, and by collecting and comparing many cases, it has been found that destructive or irritative lesions of certain parts of the brain cause paralysis or spasm of a certain set of muscles corresponding. It is probable, then, that by carefully continuing these methods of examination—that is, by describing with accuracy all states which are indicated by conditions of the muscles—we may add still more to our knowledge of the functions of different parts of the brain, and gain a further insight into the pathology of that large group of nervous centers termed functional.



SIR CHARLES LYELL.

SIR CHARLES LYELL.

By Professor GRANT ALLEN.

SIX years after Sir Charles Lyell's death, his sister-in-law, Mrs. Lyell, has given the world his letters and journals in two bulky but vastly interesting as well as really valuable volumes. The book is not exactly a biography in the ordinary sense, for the editor's part has been confined to a few stray connecting paragraphs of the baldest explanation; nor is it a deliberate autobiography, for Lyell was far too unobtrusive of his own personality to sit down and write at full length about himself; but it is unconsciously autobiographical for all that, consisting of letters extending over more than half a century, and enabling us to trace in minute detail the gradual unfolding of their writer's ideas. As a study in psychological evolution these volumes are invaluable; they set before us vividly the prior causes which produced Lyell, the environment which affected him, and the influences which molded or developed his inherent faculties. Their interest is thus rather social and personal than merely geological; it is Lyell the man, not simply Lyell the writer, that they paint for us with such graphic fidelity.

Whence did he come? What conditions went to beget him? From what stocks were his qualities derived, and why? These are the questions that must henceforth always be first asked when we have to deal with the life of any great man. For we have now learned that a great man is no unaccountable accident, no chance result of a toss-up on the part of Nature, but simply the highest outcome and final efflorescence of many long ancestral lines, converging at last toward a single happy combination. Whatever he possesses he has derived in the main from his ancestors, though he may possibly add some few elements himself by functional use; and it is not, perhaps, too much to say that the most richly endowed natures must necessarily derive many of their separate endowments from very different preceding strains. In Lyell's case the ancestral facts are clear and simple. His father was a Lowland Scotch laird, a man of cultivation and refinement, with tastes wide enough to embrace both literature and science. He was a botanist of some distinction, of whose researches into the cryptogams Humboldt himself spoke with favor; and later in life he became an enthusiastic Dante scholar, collecting every known edition, and publishing numerous translations from the Florentine poet. Thus the father already foreshadowed the special combination of tastes to be found in the son. His mother came from a good Yorkshire family—the Smiths of Maker Hall, in Swaledale—and we can well believe Mrs. Lyell's statement that she was a woman of sound sense, for all her children seem to have inherited more than their father's share of

intellect and vigor. Charles was the eldest of ten, having two brothers and seven sisters. All were able, but he was the ablest. The first-born of a wealthy and cultivated family, with ample means and ample leisure, endowed by nature with literary and scientific potentialities, brought up in the stimulating atmosphere of his own home, of Oxford, and of the London literary world, surrounded from his childhood upward by men of science and men of letters, it would have been strange if Charles Lyell had not turned out exactly such a man as we all know him to have been. He was predestined for his work by the inevitable forces of his own constitution and the environing society, and he was admirably fitted beforehand for the work he had to do.

"Unencumbered research," as Mr. Sorby calls it, is, in fact, the key-note of Lyell's history. Like most other of our greatest scientific generalizers, he was brought up in an easy position, which enabled him to devote his life to science alone, without troubling his brain about the often absorbing question of the bread-supply, that wastes the best years of so many lives fit for better things. He came to us from the eighteenth century. CHARLES LYELL was born at Kinnordy, in Forfarshire, his father's estate, on November 14, 1797. But the real home of his childhood was Bartley Lodge, in the New Forest, which his father leased for twenty-eight years shortly after Charles's birth, though the family often returned for a time to Kinnordy as their summer quarters. The fragment of early autobiography which Lyell wrote years after for his future wife gives us some pleasant glimpses of the boy's life among the big trees and shady avenues of the Hampshire woodland. He felt the charm of nature and the open air from his childhood upward. He knew every clump and every single tree in the park, and to each one he gave a separate name. At Old Sarum, whither he used to go on half-holidays from his school at Salisbury, he loved already to break the flints from the chalk to see which had crystals of chalcedony in the middle, and which had white cores of sparkling quartz. Even then, before he was eleven years old, he had taken to collecting beetles and butterflies, finding out their names from the entomological books in his father's library. This free life in the New Forest must have formed such a preparation for his future work as could have fallen to the lot of very few boys in England; nowhere else, perhaps, in this over-tilled kingdom could he have formed so just an idea of what Nature left to herself is like—though even the New Forest looks but an artificial thing, after all, beside genuine native primeval woodlands. Moreover, he luckily escaped the conventionalizing and stereotyping drill of our public schools; he was never put through one of those dismal mills for crushing out individuality, into which we turn most of our best material, so as to grind it down to the Procrustean measure of Ovidian elegiacs and Æschylean trimeters. He went to three small private schools, first at Ringwood (close to home), then at Salisbury (where

"we had the very best boys in Wilts, Dorset, and Hants"—a touch of a sort that dies out of his letters or journals with the course of time), and finally at Midhurst, in the very heart of the Weald of Sussex. He was thus spared the brutal influence of "compulsory football," which would have been substituted for the pursuit of nature in a modern public school. His tutors, indeed, shook their heads at his solitary ways, but they only gently hinted that they were unmanly. Our enlightened modern head masters would have severely reprimanded him for "loafing."

On the other hand, the boy's school-training laid the foundation for that wide and general culture which was afterward so markedly to distinguish him, even among the cultivated scientific men of his own time. The danger of becoming a narrow specialist, with no eye for anything on earth except the last rare thing in ammonites, was obviated in great part by the direction given to his natural tastes at Midhurst. He "had a livelier sense than most of the boys of the beauty of English poetry," he tells his wife, long after. "Milton, Thomson, and Gray were my favorites, and even Virgil and Ovid gave me some real pleasure, and I knew the most poetic passages in them." Scott dazzled his boyish fancy as he dazzled all the world while the present century was in its teens; and when a school competition was proposed for the best English verse in the ordinary heroic decasyllabic couplets, Lyell Senior boldly sent in his copy in the metre of the "Lady of the Lake," and won the prize, too, in spite of innovation attempted and rules openly infringed. Some burlesque Latin hexameters which he wrote about the same time lingered in his memory till past middle life—an epic suggested by the Batrachomyomachia, and devoted to the draining of the play-ground pond, much infested by predaceous water-rats. Such things are small in themselves, no doubt; every promising lad of literary tendencies at every big school has done the very same in his time, without setting the Thames on fire, after all; but they are valuable as marking the specific admixture which made Lyell something other in after-life than the mere bone-hunter or snail-catcher of scientific societies. Heaven forbid that our future geologists should all be cast in the uniform mold of the classical tripos!—but there was a certain tinge of the humane letters about these *savants* of the last generation which relieved them from the chilliness, the austerity, and the want of human interest that many people notice as a defect among the average scientific men of the present day.

At seventeen—young even for those days, I fancy—Lyell went up to Oxford. His college, Exeter, was still almost exclusively a west-country one, and west-countrymen were not popular nor remarkable in the university for polished manners. He tells his father a mythical story how some Devonshire man at Exeter was asked by the examiners, "Who was Moses?" "Moses," says the examinee, "I knows nothing about Moses; but ax me about St. Paul, and there I has 'ee."

Good evidence how long provincial prejudices lingered in Oxford, as they still linger about the Jesus Welshmen and the Balliol Scots. The letters from college (anno 1817) are amusingly old-fashioned in their eighteenth-century echoes. They are written stiffly in the literary style of the past generation, with Horace deliberately dragged in, thus:

"Hunc varum distortis cruribus."—*Sat.*

But we are gainers hereby in the end; for Lyell's epistolary style, thus developed, was very different from the hasty manner of the present day, based upon the post-card and the telegraph-form.

It was at Oxford, too, that Lyell discovered geology, hitherto to him a *terra incognita*, or, rather, *inopinata*. He attended Buckland's lectures, and seems at once to have been converted to the new love, the insects being henceforth almost entirely deserted, or, at least, relegated to the second place. One of his long vacations was spent at Yarmouth with the Dawson Turners; and already we see the theory of "causes now in action" fermenting in his eager brain. He visits the alluvial delta of the Yare, finds evidence of ancient channels blocked up by the shingle which so diverted the course of the river, learns that Norwich was a great port in mediæval history, and, putting two and two together, comes to the natural conclusion that the changes in that part of the coast were very recent, and were due, not to one of the then fashionable cataclysms, but to river-silt still in course of deposition. "Cromer, Bakefield, Dunwich, and Aldborough," he says, "have necessarily been losing in the same proportion as Yarmouth gains." The bent was there even at this early date; and it is the bent that makes the man. The old drastic cosmogony was trembling to its fall; the germs of evolutionism were already in the air. Catastrophes, special creations, deluges, and the rest, though backed by the great name of Cuvier, had had their day. Lyell was to be one of the first to discover the cumulative value of the infinitesimal. From the first, his thoughts pointed in that direction; and though he did not know to what grand results the system was to lead us in the hands of Darwin—though, indeed, he was slow to accept the results when flashed upon him too dazzlingly at last—yet it is interesting to observe how throughout he keeps a keen eye upon all the crude theories that make in the same way, such as that of Lamarck, who from the beginning exercised an obvious fascination upon his kindred mind.

Toward these final results Lyell's own work led slowly up. Perhaps it is not too much to say that in future ages, when the origin of the great uniformitarian system of interpreting nature is looked back upon with impartial eyes, four prominent names will stand out as representative of the evolutionary movement in the judgment of posterity. The first is that of Laplace, who applied it to the origin and development of sidereal systems; the second is that of Lyell, who applied it

to the origin and development of the surface of our own planet; the third is that of Darwin, who applied it to the origin and development of the phenomena of life; the fourth is that of Herbert Spencer, who applied it to the origin and development of the phenomena of mind, besides working up all the scattered elements of the system into one complete and harmonious whole. To pretend that Lyell stood up to the level of the other three would be passing the love of biographers: his work neither required nor engaged such high synthetic powers as theirs. But, without the first two, the revolution accomplished by the last two could never, perhaps, have been successfully carried out.

While at Oxford, too, general culture is not neglected. We find Lyell criticising Mr. Coleridge's new poem of "Christabel," writing some mild verses of his own on Staffa, which he had just visited with his father (better mild than none), and not quite successfully trying to take an interest in his tutor's lectures on the Ethics, where every Oxford man can surely afford him the most heart-felt sympathy. In 1818 he made a vacation tour through France, Switzerland, and Italy, observing and learning much, and interesting himself in art and society. He sees the Dranse in flood, and pores over the pictures of the Pitti Palace and the domes of Venice. Coming home, he went in for classical honors, and took a second in 1819. In after-life he evidently regretted the sort of teaching he had got at Oxford as much as most other men do; yet it left some good effects, apparent enough in all his subsequent work.

Law was to be his profession: so he went to Lincoln's Inn and made a beginning of reading. But luckily his eyes were weak, and he was sent abroad again for a trip to Rome. Here he devoted himself to the Forum Romanum and the Vatican, and left no time for geology —good education for his future work. Next, he is back in England, and down at Romney, with a friend. What luck for one of his bent: Yarmouth and Romney, the two great modern districts of England, the exact places to see geology now at work under one's very eyes! Here comes one of the jarring passages again: "The back door, opening into the farm-yard, betrays [his friend's father] to have been the farmer turned gentleman, not the gentleman turned farmer. How short and direct is the road through Eton and Oxford from the grazier on Romney Marsh to the fine gentleman!" But even here the better nature comes out on second thoughts—"or, to speak plainly, to the real gentleman in ideas, manners, and information." In the earlier letters there is a good deal of this sort of thing—talk of "good company," "my father's head livery-servant," and so forth; but we are still in the year 1822, and great allowances must be made for the son of a Scotch laird, living in the midst of the Tory society of the Regency, and hardly daring to trust his own native Liberal promptings. In politics he was Liberal from the first, though never a sound Radical; and in social matters the tone of his letters widens out steadily

with time, till after his first American trip he comes back, say his friends, "*ipsis Americanis Americanior.*"

Lyell's was a life of smooth success. It is wholly wanting in anything like plot-interest, because all honors came so easily to him. In the year in which he took his degree he was made a fellow of the Linnæan and Geological Societies. In 1823 he became secretary of the latter. Already he is a fast friend with Buckland and Mantell; and his sisters are his helpers in keeping his museum and the confidantes of his scientific theories or discoveries. About this time he makes many journeys to Paris, becoming familiar not only with French as a language, but with such men as Cuvier, Humboldt, Brongniart, and Constant Prévost. He mixes in all the best *salons* of that shameful period. Some of his letters are guarded, lest he should be "treated like Bowring, with the Bastile"; but, when he gets a chance of sending a sheet or two otherwise than by post, his pictures of the faithless, cynical, bigoted, irreligious Paris of the Restoration are vivid and graphic in every line. Humboldt confides to him his notions about Cuvier, who has dabbled in "the dirty pool of politics":

His *soirées* are mostly attended by English (says Humboldt); the truth is, the French *savants* have in general cut him. His continual changing over to each new party that came into power at length disgusted almost all, and you know it has been long a charge against men of science that they were pliant tools in the hands of princes and ministers, and might be turned which way they pleased. That such a man as Cuvier should have given a sanction to such an accusation was felt by all as a deep wound to the whole body. And what on earth was Cuvier to gain by intermeddling with politics? . . . You well know with what contempt the old aristocracy of all countries are apt to regard all new men of whatever abilities. *We* feel that but too much in Germany; but *here* it is a principle of party to carry such prejudices to the utmost length. Cuvier's situation was a proud one while he stood in the very foremost rank of men of science in France; but when he betrayed the weakness of coveting ribbons, crosses, titles, and court favor, he fell down to the lowest among his new competitors.

However, after saying so much at second-hand, Lyell adds his own opinion that Cuvier is more liberal and independent than most Frenchmen. He dares to speak well of Napoleon, the sun that has set:

We must not forget (he says) that Baron Humboldt and he are the two great rivals in science, for Laplace and the mathematicians do not come in contact with them. Humboldt's birth places him on the vantage-ground; and Cuvier perhaps tries to compensate this by a little political power. As for his *ratting* so often, *defendit numerus;* what French politician could throw the first stone at him? Humboldt's family is noble and ancient in Germany; his elder brother a man now in great power there. His talents entitle him to regard with the contempt which he expresses, and I have no doubt feels, mere rank; but we may say of him, as Chateaubriand said of our English peers, that he is well aware that, while he gets too liberal, he is in no danger of losing the station and the advantages which his birth insures for him.

The young English visitor saw all that was worth seeing in this profoundly rotten society. Making every allowance for good introductions and a less crowded stage of European life than ours, the ease with which he got to know everybody seems nowadays almost incredible. At the door of the observatory he meets Laplace, "a very fine-looking old gentleman"; and he is shown over the building by Arago in person. Madame Pichon, a famous beauty, who sat for Gerard's "Psyche," admits him to her *salon*. Férussac shows him all his snail-shells, and tells him some things about geology that he did not know before, together with many baseless theories, which his good sense cavalierly rejects. He sees something of the intriguing great world, too; some of the chameleon-colored politicians, the scheming *abbés*, the fashionable Ultras, and the still more fashionable Ne Plus Ultras, as he once calls them. "Every other man one meets is either minister or ex-minister. They are scattered as thick as the leaves in autumn, stratum above stratum." He is full of interest, too, in social and political questions; writes with acuteness anent the system of subdividing the land, discusses the centralizing tendency introduced by Napoleon, and is keen about the pensions bestowed on Pairs de France by the Bourbons *durante bene placito*—a gift which, he says, neither blesses him who gives nor him who takes it. As yet he has done nothing serious in the way of book-making; but who would exchange such preliminary training as this for the very best and carefullest field drudgery of the mere cut-and-dried technical geologist?

However, he was not idle all this time. On the contrary, he was running up and down and to and fro upon the face of the earth, inspecting its crust everywhere, with an eye to future results; and to run to and fro was of course a far more difficult thing in the twenties than it is in these later days of easy locomotion. His letters are full of his observations taken in on the spot. Now he is down in the Isle of Wight, examining the cliffs from Compton Chine to Brook, and surprised at the careless way Buckland "galloped over the ground"—"he would have entirely overlooked the Weald clay if I had not taken him back to see it" (clearly what satisfies the Bridgwater treatises and the dean in the way of research will not satisfy this very heterodox young man); now he is investigating the tertiaries of the Paris basin at Bas Meudon; and now again he is down at Lyme Regis, classic land of geologists, watching Mary Anning, the self-taught fossil-finder, unearthing the skeleton of a "superb ichthyosaurus." Every letter almost teems with new facts or discoveries; and Lyell's ears are open for everything new in the geological line from the ends of the earth inward.

In 1825 his eyes had so far recovered that he was called to the bar, and went the Western Circuit for two years. He was but a dabbler at the law, however, and fortunately never gave up to the Queen's Bench what was meant for mankind. In 1826 he was elected to the

Royal Society, ætatis twenty-nine. A year later, his review of Scrope's book on Auvergne, in the "Quarterly," clearly showed the line that he meant henceforth to adopt. He came forward as the champion of the views set forward by Hutton and Playfair—views which he was to modify profoundly, to make his own, and to stamp with the seal of universal scientific recognition. About this time he conceived the plan of the "Principles of Geology," his first epoch-making book. Shortly after, he went abroad with Murchison to France and Italy, collecting material for the great work. His letters home bristle with amusing sketches of his Sicilian experiences, for Sicily was then even more impassable off the grand route than it is now; and he often had to rough it in strange quarters. He has a keen eye for the ludicrous side of things, and tells many odd stories of men and manners. "This, signor," says his cicerone once, "is the wife of Pompey the Great, named after Pompeii; she is weeping her husband's death, who was killed at the siege of Troy." At Girgenti he sees "a droll sight. Fifteen orphan boys were paraded before the statue stark naked on a windy day, and then clothed by the bishop in the name of the king." He has time, too, besides climbing Etna, and noticing such things as the signs of the rise and fall on the famous temple at Pæstum, to look at Giotto's frescoes, and to observe much about men and politics. At the end of his tour he writes from Naples to Murchison (who had not accompanied him so far):

> My work is in part written, and all planned. It will not pretend to give even an abstract of all that is known in geology, but it will endeavor to establish the principle of reasoning in the science; . . . that no causes whatever have, from the earliest time to which we can look back, to the present, ever acted, but those now acting; and that they never acted with different degrees of energy from that which they now exert. I must go to Germany and learn German geology and the language, after this work is published, and before I launch out into my tables of equivalents. . . . This year we have by our joint tour fathomed the depth and ascertained the shallowness of the geologists of France and Italy as to their original observations. We can without fear measure our strength against most of those in our own land, and the question is whether Germany is stronger. They are a people who generally "drink deep or taste not." Their language must be learned; the places to which their memoirs relate, visited; and then you may see, as I may, to what extent we may indulge dreams of eminence at least as original observers.

It is a great thing that Lyell was able thus to devote himself entirely to his work, and to spare no expense or trouble that would render him more competent rightly to perform it. "I shall never hope to make money by geology," he said; and again, "I will waste no time in book-making for lucre's sake." To travel everywhere and see everything with his own eyes was his great idea: "We must preach up traveling, as Demosthenes did delivery, as the first, second, and third requisites for a modern geologist." In 1830 the first volume

of the "Principles" came out, and immediately achieved a marked success. No sooner was his book published, than he was off to the Pyrenees, and dashing down in his impetuous way into Catalonia. Here he mixes up in his letters the volcanoes of Olot and the salt-mines of Cardona with much amusing chat about the peninsularity of the Spaniards and the odd people he met *en route*. On his way back through France, he comes across the tail-end of the Revolution of 1830. At Perpignan he sees the cross removed from the cathedral, and hears a bystander indulge in the exquisitely French reflection: "*Chacun a son tour; le bon Dieu a eu le sien.*" Next year he is off to Germany, inspecting the volcanic region of the Eifel. About the same time he accepts the professorship of Geology in King's College, offered him by three bishops, who knew not what they did; for Conybeare vouched for his orthodoxy. Even then Conybeare must have been satisfied with very little. Lyell did not keep the chair, however, as it interfered with his schemes of traveling and original research. So he returned immediately to his tours, much to the ultimate advantage of science, and no doubt to the great satisfaction of the hesitating episcopal triumvirate.

During all these bachelor years Lyell was daily mixing with the most cultivated society of the time. In every letter half a dozen well-known names catch the eye at once. On one page, he is dining at Craig Crook Castle with Francis Jeffrey, "a great treat," and meeting "Mr. Maculloch, who gave the celebrated lectures on political economy in town last summer, which I attended"; on another, he is breakfasting at Lockhart's with Sir Walter Scott, "a far more genteel-looking man than Phillips has represented him in his portrait"; and on a third, he is at Cambridge, playing whist with Copley, Master of the Rolls, afterward Lord Lyndhurst, and chronicling only "a stiff bow" from highly-aristocratic young Lord Palmerston, who must then have been strangely different from his later easy-going self. Mrs. Somerville was always a close friend, and he even chaperones her to a Sunday evening "At Home" at Sir George Phillips's, where they meet Yankee novelist Cooper, politico-economical Mrs. Marcet, ethical Mackintosh, poet Rogers, Benthamite Dumont, Conversation Sharp, Sir Walter himself, and a dozen other assorted notabilities. Sir John Herschel, too, was an equally early ally, to whom many of the letters are addressed. Lyell is very catholic. He goes to hear Paganini, not enthusiastically; and then he goes to kirk to hear Chalmers, and retains enough of the Scotchman about him to characterize the sermon as "a very long discourse, but admirable." This catholicity comes out in far stronger relief in his letters than even in his published works, which stick comparatively close to the matter in hand. One sees it over and over again in such little touches as his first notion that he might write the "Principles" as conversations on geology, in the form of "a dialogue like Berkeley's 'Alciphron,' between equals." How many geologists of

the new school have ever heard of the 'Alciphron,' or even know Berkeley in any other way than through one eternal quotation from "Don Juan"?

In 1831 the journal written for his future wife begins, so that we may conclude he was then or thereabout first engaged. In 1832 he married. His wife was a daughter of Leonard Horner, and a lady of tastes very similar to his own. Perhaps one may hint that all the ladies of Lyell's family were a trifle more learned than all the world would care for: it must have been rather a strain to live up to such a constant stimulation in the home circle; and most men would hardly wish to fill their letters to their wives with highly interesting details of dip, strike, and horizon. But this is a matter of personal taste. Lyell seems to have been one of the giants who can stand such incessant high pressure; and he was probably all the happier for his well-assorted marriage. He himself seems strongly to have believed that bachelorhood was not good for the cause of science.

The summer of 1834 was spent in Scandinavia. Lyell was delighted with all that he saw in this new field. "There is much doing here which is unknown in England and France," he writes from Copenhagen. "I am more than ever struck with the extreme slowness with which science travels, what with multiplicity of languages, *douanes*, etc." If even Lyell felt this, though he spoke English, French, and Italian fluently, German well, and Spanish a little, how much must it stand in the way of lesser people, with smaller means and narrower accomplishments! After seeing Denmark from top to bottom, he crossed to Malmö and Lund, and did the Peninsula pretty thoroughly. At Stockholm, Berzelius took him in hand and gave him the cream of all he knew; at Upsala, it seems a strange link with the infancy of science to read that the daughters of the great Linnæus himself showed him over their father's garden. Conversation was limited to German, eked out, when needful, with Latin, which Lyell often found of service as a *lingua franca* in out-of-the-way places; but educated Scandinavians usually speak English so well that even the most helpless foreigner is seldom at a loss. He seems to have been as pleased with the peaceful and simple descendants of the wickings as most other people, and to have returned to Scandinavia with special pleasure on future visits. In 1837 he took his wife with him, and made further investigations on the geology of the Baltic basin, which stood him in good stead in his later works.

Naturally, as he grew older, after the "Principles" and the "Elements" had made their mark, he became an authority, and saw even more of the best intellects of the time than before. His correspondence with Mr. Darwin—not yet the apostle of evolution—seems to date from this period, and the allusions to London society crowd more and more thickly on every page. The tone, however, remains unchanged. Not a trace of narrow specialism anywhere. We get long accounts of such

events as a party at Milman's, where Rogers and Whewell discuss Pope, and where Milman gives the fresh opinion of a contemporary on Macaulay's "Bacon." To follow him in all his wanderings after the age of railways would be impossible: a run across to Spain, Italy, or Scandinavia, seemed to him merely an ordinary bit of his week's work. In 1841, however, he took a more ambitious trip across the Atlantic to lecture at the Lowell Institute, and then traveled through much of the United States and Canada. Geologically, he was deeply impressed by the great scale of the phenomena he saw, the vast lakes, the enormous glacial deposits, the immense subterranean forests; socially and politically, the trip left lasting effects upon his tone of mind. Singularly unprejudiced to start with, he met American society frankly and cordially, and judged both its merits and defects with somewhat lenient impartiality. But his kindliness was not the result of mere unobservant and uncritical good nature. He kept his eyes open, as usual, to all the main sociological factors, and rightly remarks that many Englishmen set down much to American political institutions which is really due to American circumstances—abundant land, free elbow-room, and constant European immigration, often of the poorest and most ignorant class. On the other hand, when he crosses the border at Niagara, he sees the weak points of the colonial system on the north of the Great Lakes keenly and acutely:

> You and I would hear more in good society here (in Canada) in one week (he writes to Leonard Horner), which we should consider narrow-minded and prejudiced and ungenerous to foreigners, in matters of politics, religion, and political economy, than we heard in nine months in the United States; for they have here all the Kleinstädterei of a colony and the enmity of the borderer, added to everything that you might disapprove of which they bring from home.

This is less true now than it was then, but there is still much truth in it; and it is painful to think that we have condemned Canada to such a poor and petty mock-national existence for forty years longer, since Lyell wrote, merely for the sake of our own meaningless imperial claim, which nobody ever seriously means to assert, but which everybody pretends to believe is vastly important. The interesting thing to note here, however, is the fact that Lyell should have come to so definite and just a conclusion after only a few weeks' sojourn in a new country. It is one of the many proofs of his keen practical penetration which lie scattered over every page of his memoirs and journals.

Perhaps the chief visible results of this first American trip was the formation of a close friendship with Mr. Ticknor, of Boston—a member of the well-known publishing firm—to whom many of his letters are henceforth addressed. They are among the most interesting he ever wrote, containing expressions of broad general opinions, which would hardly be needed in writing to European friends. Some of

them are very characteristic at once of his wide tolerance and his marked tendency toward conciliation and compromise. For example, he writes once:

> The time may be nearer than some think, when we shall have all sects endowed, which I trust will happen, instead of none being so. But, at all events, I abhor the political disaffection created in Ireland, Scotland, and England by the exclusive privileges of Church of England ascendency. It is really the power which is oppressive here, and not the monarchy, nor the aristocracy. Perhaps I feel it too sensitively as a scientific man, since our Puseyites have excluded physical science from Oxford. They are wise in their generation. The abject deference to authority advocated conscientiously by them can never survive a sound philosophical education.

He made altogether four voyages to America, always with an increasing sympathy for whatever is best in American life. Slavery troubled him much. He saw that the slaves were fairly well treated; that they worked lightly, fed well, enjoyed themselves hugely, and were profoundly careless about their own condition. He thought that, "if emancipated, they would suffer very much more than they would gain," and just at first he was half disposed to palter and parley with the accursed thing. But more thinking brought him back to himself; and, when the War of Secession came, he was firm as a rock on the right side, when all English society was going steadily wrong. No political movement of his time seems ever to have interested and excited him so much.

"If the result of the struggle," he writes to Mr. Ticknor in the very thick of the war, "could be the abolition of slavery by the year 1900, it would be worth a heavy debt and many lives, at any rate when one thinks of what most wars are waged for, not but that the Union alone is worth a long fighting for." And the longest letter, I think, in the whole correspondence, is one to his friend Mr. T. Spedding, defending his faith in the North against adverse criticism—a manly, noble, outspoken letter, which by itself sufficiently stamps its writer. A few condensed extracts are well worth making:

> I admit that every people have the right of rebellion or revolution whenever they are oppressed. . . . But, so far from having any just grounds of rebellion, the South had been dominant to the last in foreign and domestic politics, had always had the lion's share in the choice of Presidents and other civil appointments. . . . In short, they rebelled simply because Lincoln's election showed them that the Republican party were at last determined to resist the extension of slavery into new Territories. . . . If such men as Gladstone and Earl Russell had been only six weeks in the United States, they would never have said what they did. . . . Lincoln and his colleagues are not the sort of men that you and I would put into a Cabinet, so far as their conventional manners are concerned; . . . but, after all, are Lords Palmerston, Clarendon, and some others, men of higher principle than Lincoln, or as high? I am intimate with men equal to any here in literary attainments and in polish of manners, and of independent fortune, in the United States, whom I used to wish to see in power

instead of the coarser class into whose hands the reins of government have been placed. But these men and the majority of capitalists would, I am sure, have knocked under to the South, and the slave-owner would have made a compromise by which his institution would have been more rampant than ever. If slavery, which was more injurious to the white man than to the negro, and which to a certain extent poisoned the political institutions of the North, . . . is got rid of, it will be owing to a very extended suffrage among a class which has had much instruction, for working-men, but to whom the aristocracy of wealth and refinement were not prepared to make great sacrifices for such an object.

In a man of Lyell's antecedents and position, such reasoning is both brave and unexpected. I regret to say he observes in the same letter that he would rather fight for any number of years than let Ireland be "independent," though he admits that the Irish might make out a fair case for "repeal." Like most English Liberals, he can be just and sympathetic to Venetians, Poles, Hungarians, and negroes, but can not go quite so low as Irishmen.

So much by anticipation. A life like this is so full of real triumphs that one almost forgets to mention such a small matter as that in 1848, when at Kinnordy, "he rode over the hills by Clova and Lochna-gar to Balmoral, when he had the honor of being knighted by the Queen." He was Englishman enough to appreciate the distinction, as well as the baronetcy which followed it later on. Nor was he insensible to the blandishments of royalty: he records the doings of little princes and princesses, when he happens to meet them, a trifle too much in the style of the special correspondent, and he details his conversations with a distinguished personage somewhat more fully than their intrinsic nature really demands. But there is not much of this sort of thing: as a rule, when he mentions a man, it is because the man is worth mentioning. The life in London during the years of full maturity is even richer in reminiscences of famous people than the earlier days. Dining at Hallam's, the great subject of conversation is the vacant editorship of the "Edinburgh"—Longman closeted for hours with Macaulay, and Jeffrey strongly opposed to letting the control go from Auld Reekie. Breakfasting at Rogers's, the veteran poet tells him how he knew a boatman who used to ferry Mr. Alexander Pope across the river at Twickenham, how Chantrey once came to his house as a workman, at five shillings a day, to receive orders for some ornamental drawing-room furniture, and how he still possessed the identical table at which Addison wrote his "Spectator" papers. Now it is "Ruskin, who was secretary of our Geological Section"; now it is "a friend of mine, Huxley, who will soon take rank as one of the first naturalists we have ever produced"; and now it is "young Geikie, . . . certainly the coming geologist and writer." His eye for men was very keen, and his predictions have almost always turned out to be correct. Of Agassiz, just settling in Boston, he says: "He will

be the founder of a school of zoölogy (for he has many pupils) of a high order. His enthusiasm is catching, especially when he has a good soil to work upon." Nor do his interests narrow at all with years. "I sat long before the Madonna di San Sisto to-day," he writes from Dresden, "and can feel its beauty." At Madeira, Teneriffe, the Grand Canary, and Palma, he enlarges his notions by new sub-tropical experiences. But the great scientific and philosophical revolution of the present century burst upon him, after all, half unprepared. He has long ago demolished the Mosaic cosmogony; he is deeply interested in Bishop Colenso; he has already strong views as to the antiquity of man; and yet Mr. Darwin's "Origin of Species" comes across his horizon at last almost like a thunder-clap. The truth is, he was committed to the opposite belief, and he was old for a sudden revulsion. He accepted the new creed, indeed, slowly and cautiously, but he had a struggle for it, and it cost him hard.

Lyell's attitude toward the grand theory of the origin of species by descent with modification was, indeed, in many ways a singular one; and these letters throw much light upon the evolution of his ideas with regard to it. Though his own views as to uniformitarianism and the antiquity of man might seem naturally to lead toward the acceptance of the development hypothesis—for it is much more difficult to imagine creation taking place in the midst of an ordinary physical series of events than to imagine it taking place in order to restock a world desolated by a divinely ordered cataclysm—he formally rejected the theory as broached by Lamarck, and he hesitated for some time to accept it as altered and amended by Darwin. Indeed, to the last he was but a lukewarm convert. Unless my memory misleads me, I have heard Mr. Herbert Spencer say that the true test whether a man was an evolutionist in fiber or not was to be found in the question whether he accepted evolution before Mr. Darwin had made its *modus operandi* intelligible. There are men who rejected the doctrine of special creation on evidence adduced; and there are men who never for a moment even entertained it as conceivable. These latter may not always have seen the πῶς of evolution, but they always saw the ὅτι. Judged by such a standard, Lyell occupies a middle position. From his earliest days he seems to have hankered after some such naturalistic explanation of life, and yet to have feared cordially to accept it. In 1827 Mantell sent him Lamarck, when he was on circuit at Dorchester. He writes back shortly after:

> I devoured Lamarck *en voyage*, as you did Sismondi, and with equal pleasure. His theories delighted me more than any novel I ever read, and much in the same way, for they addressed themselves to the imagination, at least of geologists, who know the mighty inferences which would be deducible were they established by observations. But, though I admire even his flights, and feel none of the *odium theologicum* which some modern writers in this country have visited him with, I confess I read him rather as I hear an advocate on the wrong

side, to know what can be made of the case in good hands. I am glad he has been courageous enough, and logical enough, to admit that his argument, if pushed as far as it must go, would prove that men may have come from the orang-outang. But, after all, what changes species may really undergo! How impossible will it be to distinguish and lay down a line beyond which some of the so-called extinct species have never passed into recent ones!

The last two sentences show how, even then, Lyell was trembling upon the brink of the truth. He had got in the thin end of the wedge; he was prepared to admit the first infinitesimal in the long series whose sum makes up at last the difference between himself and the amœba: and yet he refused to go any further.

Time after time, for many years, we find the same thing cropping up again. The question is always before him, though he wavers much in the way he regards it. It seems to fascinate him and draw him on; even when he is fighting against it, it appeals to him as the natural complement of his other beliefs. In 1830 he writes to his sister from Paris:

This morning all my Etna shells were examined; out of sixty-three only three species not known to inhabit the Mediterranean, yet the whole volcano nearly is subsequent to them, and rests on them. They lived, on a moderate computation, one hundred thousand years ago, and, after so many generations, are quite unchanged in form. It must, therefore, have required a good time for orang-outangs to become men on Lamarckian principles.

Any one can see the falsity of this reasoning, which would imply an absolute uniformity in the rate of change in nature everywhere. A little later, in 1836, he writes to Sir John Herschel:

In regard to the origination of new species, I am very glad to find that you think it probable that it may be carried on through the intervention of intermediate causes. . . . An insect may be made in one of its transformations to resemble a dead stick, or a leaf, or a lichen, or a stone, so as to be somewhat less easily found by its enemies; or, if this would make it too strong, an occasional variety of the species may have this advantage conferred on it; or, if this would be still too much, one sex of a certain variety. Probably there is scarcely a dash of color on the wing or body of which the choice would be quite arbitrary, or which might not affect its duration for thousands of years.

In some ways this is marvelously near Darwin; but in others it differs *toto cœlo;* for Lyell does not see that these variations could arise "spontaneously," that is to say, in the ordinary course of small differences of antenatal conditions; he sets them all down directly to "the Presiding Mind." Nor does he see that they might result at last in the production of new species. Indeed, the context, which I have suppressed, takes off much from the superficial air of anticipating Darwin, which the passage nakedly quoted undoubtedly bears. A year later he tells his sister—

The latest news is that two fossil monkeys have at last been found—one in India, contemporary with extinct quadrupeds, but not very ancient, Pliocene,

perhaps; another in the south of France, Miocene and contemporary with Paleotherium. So that, according to Lamarck's view, there may have been a great many thousand centuries for their tails to wear off, and the transformation to men to take place.

In 1854 he notes, after an evening at Mr. Darwin's, how Sir Joseph Hooker astonished him with an account of that strange orchid, Catasetum, which bears three totally distinct kinds of flower. "It will figure," he says, "in C. Darwin's book on species, with many other 'ugly facts,' as Hooker, clinging like me to the orthodox faith, calls these and other abnormal vagaries."

Two years later, speaking of the wingless beetles of Madeira, he asks, "Was it not foreseen that wings would only cause them to be blown out to sea and be drowned?"

Soon after, meeting "Huxley, Hooker, and Wollaston at Darwin's," he is constrained to ask, "After all, did we not come from an orang?" At last the "Origin of Species" comes out, and bit by bit Lyell is compelled to give in. Even then he can reconcile himself but slowly to the new creed. "I plead guilty," he writes to Sir Joseph Hooker, "to going further in my reasoning toward transmutation than in my sentiments and imagination, and perhaps for that very reason I shall lead more people on to Darwin and you than one who, being born later, like Lubbock, has comparatively little to abandon of old and long-cherished ideas, which constituted the charm to me of the theoretical part of the science in my earlier days, when I believed with Pascal in the theory, as Hallam terms it, of 'the archangel ruined.'" To Mr. Darwin himself he writes that "the descent of man from the brutes takes away much of the charm from my speculations on the past relating to such matters." In the end he comes to the conclusion, as he idiomatically puts it, that "we must go the whole orang"; for that old mode of envisaging the facts clings to him to the last. Finally, he writes: "The question of the origin of species gave me much to think of, and you may well believe that it cost me a struggle to renounce my old creed. One of Darwin's reviewers put the alternative strongly by asking whether we are to believe that man is modified mud or modified monkey."

I have illustrated this matter thus fully because it is one which very clearly shows the weak side of Lyell's intellect. With all his breadth of mind and freedom from prejudice, he was not ever one of those who really get to the very deepest bottom of things. His tendencies were all in the right direction, and his instinct inclined him always to the true solution; but he did not build himself up a set of first principles to start with, firmly based upon a philosophical foundation, and make these the fixed criteria of his judgments throughout. His was too English a mind for that. He clung to all old beliefs as long as possible; he parleyed and temporized with the enemy; he was for effecting a compromise wherever he could, a patched-up *modus*

vivendi which had to be tinkered anew at every fresh discovery. To the very last his acceptance of evolution was but half-hearted; he never came out and gave it the right hand of friendship fearlessly; he was always making reservations and starting difficulties, although his own beliefs fell short of it in places only by an infinitesimal fraction. "No miracle and no catastrophes in the cosmical system," he seems to say from time to time; "no miracle in the evolution of our planet; no fresh creations *en bloc* to repeople a desolate world; but just a very tiny miracle now and then, somewhere behind the scenes—a single new species to be created at a time, very unobtrusively, in Australia perhaps or St. Helena—that is all I ask." Whereas a thoroughly logical mind, a mind of the very highest order, would have said even before Darwin: "Creation can have no possible place in the physical series of things at all. How organisms came to be, I do not yet exactly see; but I am sure they must have come to be by some merely physical process, if we could only find it out." And such a mind could not fail to jump at the Darwinian solution the moment it was once fairly presented to it.

At the same time it would be unjust to deny that Lyell possessed and retained throughout life an unusual plasticity of thought and modifiability of opinion. It was no small thing that long after his sixtieth year he should have had the courage formally to recant in print the condemnation of "transformism" in his earlier works, and to accept, however unwillingly, the theory that he had so often and so deliberately rejected.*

A somewhat ungenerous critic has lately declared that Lyell often shut his eyes when brought face to face with evidence adverse to his own views. These letters abound in proofs to the contrary. Twenty years before the publication of the "Origin of Species," he writes on another subject to Sir John Herschel:

> I am very full of Darwin's new theory of coral islands, and have urged Whewell to make him read it at our next meeting. I must give up my volcanic crater theory for ever, though it costs me a pang at first, for it accounted for so much—the annular form, the central lagoon, the sudden rising of an isolated mountain in a deep sea, all went so well with the notion of submerged, crateriform, and conical volcanoes, of the shape of South Shetland, and with an opening into which a ship could sail. . . . Yet, spite of all this, the whole theory is knocked on the head, and the annular shape and central lagoon have nothing to do with volcanoes, nor even with a crateriform bottom.

The same spirit comes out in many other places. "I am sure I have no *objection*," he says in one place about some disputed Old Red

* It is curious to note, however, that he never seems quite fully to have realized the immense difference between Mr. Darwin's view and Lamarck's. *A priori*, creation is from the first unbelievable; but, as a matter of evidence, Lamarck failed to make evolution comprehensible, while Mr. Darwin succeeded in doing so. Hence he was able to convert many who, like Lyell, were hanging back and waiting for *a posteriori* proofs. Yet Lyell himself never wholly recognized the difference.

fish-scales, "for I would as lief start with vertebrated animals and fresh water as with a universal ocean and the simplest forms of animal life." Perfect loyalty to fact, a complete readiness to accept anything, provided it can be shown to be true, marks Lyell's procedure throughout. It is very clearly seen in the last great work of his life, the "Antiquity of Man." As a matter of taste, it is obvious that Lyell did not relish the application of evolutionism to his own species. But he found that the facts compelled him, and he gave in. No book ever published—not even the "Origin of Species" or the "Descent of Man"—did so much to shake the common belief in the origin of our race: so far as all thinking Europe was concerned, Lyell simply demolished the current cosmogonies. More than that, by incorporating in the book Professor Huxley's remarks about the Neandearthal skull and much similar matter, he advertised the new creed in the animal origin of man with all the weight of his European reputation. The last years of his life were almost wholly spent in investigating this question of antiquity. Fifty years before, when he was at Oxford, he noted the occurrence of certain "pear-shaped flints" at Norwich, which he supposed must have "owed their shapes entirely to animals"; and all through his life he had been especially interested in the glacial period and its remains, the border-land where geology merges imperceptibly into archæology and history. But from the Darwinian era onward he turned his attention almost entirely to the question of antiquity. He inspected everywhere, and got abundant specimens from abroad, at times not without ludicrous difficulties. Dr. Falconer had procured him a fine cast of a fossil rhinoceros; at Naples the police voted it an infernal machine, and confiscated it accordingly. After a time it was restored, but the priests kept Dr. Falconer's osteological notes, which they declared to be treasonable, as no doubt they were from an ecclesiastical point of view. After some years spent in hunting palæoliths and weighing evidence (which involved some heavy field-work for so old a man, in the Bedford drift, the Liége and Maestricht caves, and so forth), the "Antiquity of Man" finally appeared in February, 1863. In three months he had sold five thousand copies, a remarkable success for such a book. It was his last great serious work. The remaining years of his life, though still actively spent, were devoted mainly to reconsideration and revision of what had been already done.

In February, 1875, his great and useful life closed quietly and worthily. In reviewing the seventy-eight years of his labors, it is impossible to avoid seeing throughout how admirably his opportunities were adapted to the work he had to do. He was the right man, to start with; but the lines also fell to him in the right places. With equal abilities, equal ardor, and equal singleness of purpose, he could not have done so much without the happy conjunction of circumstances as well. On the other hand, the lesson of his valuable life

throws only into stronger relief the utter waste of powers and opportunities on the part of most other Englishmen in like positions. Ninety-nine people out of a hundred, put in Lyell's place, would have been nothing better than masters of fox-hounds or slaughterers of tame pheasants. When one thinks of the life-work performed by such men as Lyell and the great band of thinkers to which he belonged, one sees only the best side of wealth and position: one feels for a moment half inclined to thank the constitution of things as they are here in England for the chance it offers to such broad-minded and comprehensive workers as these. But then one thinks also of the extraordinary rarity of men who so make use of their opportunities, who regard their wealth as anything more than an easy means of the vulgarest personal gratification. It is lamentable to remember all the thousands of conservatories all over England in each of which, without perceptible difference to the owner, a few useful experiments might be tried, a few valuable observations made; and yet how many of them are ever used for any other purpose than to provide distorted flowers for a dinner-table, for a lady's hair, or for a fop's button-hole? We must congratulate ourselves if now and then, at rare intervals, we get a single Lyell out of all this mass of wasted humanity. After all, that result is in itself a great thing. We have always enough of narrow specialists in science, men valuable and important in their own way, though that is not the highest way; but we have never too many of the great co-ordinating and organizing intelligences, who take the scattered strands of scientific thought, and weave them together into one consistent and harmonious whole. Among such men as these Lyell stands well to the front, though not exactly in the very first rank.—*Fortnightly Review.*

TO EAT AND TO BE EATEN.

By CHARLES MORRIS.

NATURE has many of what we are accustomed to call the small economies of life. She does nothing without a purpose, and she has a horror of waste. In the world of living beings, particularly, is she careful of her materials. It is no easy lift to bring matter up to the organic level. She has to call in the sun to her assistance, and get their united shoulders under the load, ere it can be raised to the required height; and she can not afford to let it down again while there is any pith left in it.

It is interesting to follow her through this portion of her housekeeping, and watch the care with which she gets all the life-force possible out of her organic stock in trade, letting not a crumb go to

waste. She invites a guest with a special appetite for every morsel—guests furnished with teeth to rend, nip, and gnaw, claws to tear, augers and chisels to bore and gouge, saws, drills, punches, and suction-tubes—that no fragment of the feast shall be left on the unswept tables.

There are guests of every shape, size, and description, alike only in the one particular of being normally hungry. Like the sitters-down at a public dinner, they all seem to have been saving up appetite for the occasion. Some there are, indeed, of such omnivorous tastes that we would be quite willing to have them left out from the general invitation. But that is not Dame Nature's way. Every crumb must be eaten; and we know little of her facility of invention if we imagine that she can not find a tooth for every hard morsel. She is ready for any such emergency, and you will be bound to find some queer creature gnawing away at the indigestible fragment with as much zest as if it were a dish fit for a king.

Let us take a sly glance in at Nature's kitchen and watch her guests at their meal. We shall not call it breakfast, dinner, supper, or lunch, for there is no such formal division. It is a whole-day feast, and a whole-night feast, too, for that matter. The tables are always spread, the guests always hungry; they crowd in from high-ways and by-ways; always one ready to take up every vacant knife, fork, and spoon; or to plunge in with fingers, teeth, and claws, in the true primitive fashion.

Nature does her cooking by sunlight. The great, glaring sun is her cook-stove, and by its aid she concocts, from such materials as water, carbonic acid, and ammonia, various palatable dishes, such as sugar, bread, fruits, greens, and a host of similar delicacies.

"There is your dinner," she says, "make yourselves at home." And so they do, without waiting to hear the dinner-bell; rich and poor, high and low; the dainty epicureans confining themselves to the fruits and seeds; others feasting on the green leaves and the lush grasses. But these are only the nobility, those who sit above the salt. The commonalty are more greedy and less particular. They bore in and saw in and dig in. Leaf and flower and fruit, branch and stem and root, each has its epicures. Some take a mean advantage by laying their eggs in the heart of rosy apple or luscious pear, so that their babes may revel in a perfect mountain of provender. There they lie, odd little white worms, like the chap who wished that Lake Superior was all ice-cream, and he plunged into its midst and condemned to eat his way out.

It has been no trifling task to lift that lofty tree or that broad field of waving grain up out of the lifeless world, and Nature is bound to make it pay its full duty to the world of life before it drops back again. It is her business to set going all the variety and abundance of life possible, and tree, grass, and grain must furnish food for

those high-strung creatures who can not, like these plants, live on rock, dust, water, and air, but must have their victuals ready cooked and served.

Look at the throng of vegetarians! Here is man, daintily plucking the luscious fruits and juicy berries, the rich seeds and fat roots, and extracting sugars and wines, vinegars and spices, to make his meal palatable. Yonder are the hosts of the cloven-footed, perfectly content to grow fat upon leaves and grasses. And here are armies of humbler guests—cherry-pecking birds, honey-sucking bees, leaf-eating grubs, that convert the waving banner of a leafing tree into one great spider-web, and then perchance go to sleep in hammocks of silk; carpenters and miners who bore into the hard wood itself, and leave behind them long, winding galleries that look like the lanes and alleys of an Old World city; locusts, army-worms, and potato-bugs that ruin man's harvests; and millions of centipeds and millepeds, ticks, mites, and gnats, that suck the living juices and fatten on the palatable meat of the tree.

But all this is only the beginning of the feast. What we call death is only, in another sense, the spring-tide of life. The leaves fall and rot, the grass decays, but not to return to the inorganic world. They are dished up as food for new waving fields and flaunting leaves. In the chemical balance of Nature part of this nutriment bears down its side of the scale into the lifeless world, yielding force to lift the nutriment in the other scale back again into the circle of life.

And when the great tree dies, what then? Its dead body is but a vast nursery of life. The long, lithe, twisting and clinging parasites, that have drunk its blood while alive, are replaced by flat lichens, umbrella-like fungi, and luxuriant mosses, which feast on its decaying trunk; while borers, chiselers, and miners do their part in transforming the great dead mass again into living forms.

And when it drops into a heap of decaying vegetable flesh, what new hosts of life batten upon it! And when the earth takes back the ruins of the dead giant beneath her generous breast, it is not to keep them there. They have too much vitality left for that. They climb to the air and the sunlight again in grasses and ferns and airy little plants. They blossom into flowers, eye-gladdening, honey-yielding, color-mad clumps of bloom, from which not alone the bee drinks sweets.

Thus is the fallen tree transformed into multitudinous life, bursting above the soil in new generations of beauty, until scarce a shred remains that does not live again. And creeping rootlets of trees hunt these last fragments underground, and crawling, flexible worms eagerly swallow the earth itself, and digest from it the stray crumbs of the old tree that are mixed throughout the soil.

Nor have we yet got to the bottom of this cycle of vegetable life. There are worlds, solar systems of life beneath all this, dwelling far

below the reach of the eyesight of man. Let some of the decaying stuff fall into standing water, and there, under the hot summer sun, slowly dissolve. Put, then, a single drop of this water under the microscope, and let us try to rediscover the fibers and flesh of our tree. Lo! instead of this dead matter we behold a swarming, writhing, twisting, shooting, creeping sea of life, thousands, millions of living forms into which Nature has transformed her seeming organic waste: the rod-like bacteria, the boat-like diatom, the globe-like volvox, the line-like algæ among vegetables; and among animals the arm-making amœba, the whip-lash monad, the shelled and twisted foraminifera, the strangely-varied infusorian; there, where to the unaided eye all seemed death and stagnation, lies a bewildering phantasmagoria of created things, life crowding in indescribable multitudes and numberless variety out of the heart of death, the eaters and the eaten in innumerable profusion. Such is the full cycle of the life of our tree; such the boundless variety produced by Nature's economical administration of her materials.

But let us not imagine that we have yet exhausted the subject. Nature is in no readier mood to waste animal than vegetable food. It also must do its duty in widening out the circle of life. Animals prey on animals. Alive and dead they are eaten and re-eaten. Animal, like vegetable life, is turned again and again into new life, until every atom of it has had all its vitality squeezed out, and has fallen, bit by bit, back into the inorganic world.

The carnivora equal, if they do not exceed, the herbivora in number. The flesh which the latter has formed out of plant material the former rends and consumes, turning it into new animal forms. And so the endless metempsychosis of life goes on, the great preying upon the small, the greater upon the great, and man indiscriminately upon all, little that is eatable escaping his omnivorous appetite.

It is all one to Nature. She is determined that there shall be no waste, that none of her laborious efforts to build the organic out of the inorganic world shall be for naught, and that the utmost abundance and most endless variety of life shall flow into being out of the bosom of the inanimate.

It is not alone the battle of the great upon the small, the strong upon the weak. The small as well make their harvest upon the bodies of the great. As minute plants feed upon great trees, so do the midges upon the giants of the animal world.

Insects are not content with preying upon one another—spiders dragging their nets through the air for unwary flies, ant-lions digging sand-craters for curious ants, ichneumon-flies nestling their young in the bodies of fat caterpillars—but they prey as persistently upon the world of giant animals.

Look at these minute pests of man, for instance. How little Nature seems inclined to exempt her best and highest from the inexorable

law of to eat and to be eaten! The name of the creatures, who fondly imagine that this fair human form was spread as a banquet for them, is legion. Gnats, ticks, lice, mites, flies, fleas, mosquitoes, form a few of our temperate host, while in torrid regions they swarm in tenfold profusion and variety, causing the happy dwellers in the land of eternal summer to spend a considerable portion of their lazy days and nights in the monotonous labor of scratching, slapping, squirming, and perhaps occasionally swearing their jaw-breaking oaths at the torments which surround them.

And inside as well as outside man is a harvest-field for the midges. Worms of unpleasing variety infest him in every organ, troubling not alone the digestive region, but lying hid in the firm flesh, the brain, even the eye. And that minute but multitudinous creature with which a pork diet furnishes him—the trichina—makes the whole body its home, and literally eats him up alive.

Nor has our economical mother Nature more mercy on her other gigantic creatures than upon man. They are all the prey of some special insects or other parasites. And not alone the great, but the small, for we perceive creatures visible only under the microscope that form the homes of still smaller parasites. It becomes, indeed, an unpleasant wonder what marvelous adaptations of animal life have been formed apparently for no other purpose than to batten and fatten upon and make miserable all larger creatures, for whose greater size they make up by vaster multitudes.

It is economy all. There must be no waste of organic material. If some suffer thereby, it is their misfortune. The law can not be set aside for special purposes. There are no good ends ever gained without certain unpleasant drawbacks. The end here to be gained is life—abounding, immeasurable life. To reach this result, no organic force can be spared, and if some have to scratch and squirm, still it will be found here, as in all Nature's economies, that the evil is small, the good attained great. She works by law alone, and a law of Nature is never laid aside because it happens to tread on some crippled creature's corns. Law is immutable, and will inevitably crush every laggard who is not strong enough or quick enough to get out of its path.

And when the animal dies, it dies not to drop at once into the dust whence it sprang. Its dead flesh is too valuable life-building material to be allowed to escape Nature's uses in any such hasty fashion. Complete death can only be reached by the road of life. The mineral world is too far off to be arrived at by a single downward step. Successive steps are necessary, and every step is a living form. What we call fermentation in plants is but a growth of new plants out of the stuff of old ones. And putrefaction in animals is but another form of the same process.

As we have seen a host of plants growing out of the ruins of the

dead tree, so we now perceive a host of animals growing out of the ruin of their dead predecessor. What is not otherwise devoured serves as a receptacle for the eggs of insects, and it soon swarms with grubs and maggots, destined eventually to sail in winged lightness in the air, without a hint in their aërial grace that their floating life had this unpleasant source.

And they shall be eaten—and their eaters eaten; and thus the organic world, which grew up by this devouring process from the smallest plant to man, slowly drops back by form after form through the lower world of animals and plants, until every grain of vitality is sucked out of it, and it falls at last, utterly juiceless and lifeless, into the mineral world from which it came.

Such is Nature's most striking economy. Such the work she gets from the subscriptions from the lower world, ere they are paid back into the treasury whence they were drawn. They form the coin of life, passing from hand to hand, and abraded by every touch, until utterly worn away, and needs to be replaced by new coins from the organic mint.

And there is yet another feature in this round of economies with which we may safely close our review. Nature not only provides us with new food, but makes our old nutriment do duty again and again, ere every possibility of use is squeezed out of it. Thus the nitrogenous material of the body, which is thrown into the circulation by waste of the muscles, does not appear to be at once carried out of the body as useless refuse. It is too precious to be so lightly thrown away. On the contrary, it is probably worked over again in the blood, a portion of it becoming mineral matter, and yielding force to lift another portion into the condition of nutriment. A similar process of reemployment of nitrogenous material takes place in vegetables. Thus, a part of the coin is worn off, and the remainder paid back into the bank of life for its existing value. And so it may be paid back again and again, until it is all lost in this successive wear and tear, and the mineral world gets its own again.

This is Nature's thrifty housekeeping. Not an ounce of force is wasted. All the possible life in organic material is worked out of it ere it can escape. And even those vegetable forms that have avoided this process by being turned into stone have but temporarily locked up their forces, which flow out eventually in the form of light and heat, to invigorate, vivify, and gladden the world of living beings.

MATERIALISM AND POSITIVISM.

By W. D. LE SUEUR.

MATERIALISTS and positivists are commonly classed together by those who have never well understood what either materialism or positivism really is. Positivism is supposed to be materialistic because it fails to call in spiritual existences in explanation of phenomena—because, in other words, it stops short at facts, and does not seek to search out ultimate causes. The people who draw this inference take for granted, apparently, in their ordinary thinkings, that all facts must be facts of matter, and that those who confine themselves to facts must consequently be materialists. There is, therefore, really a fundamental materialism in the very criticism that fastens upon positivism the charge of materialism. Let us, however, look a little more closely into materialism considered as a mode of philosophical belief.

What do we mean by matter? First of all, it is obvious that we mean something that is objective to the mind or thinking faculty—something the mind finds upon its path, as it were, and that is the source to it of certain definite impressions. All impressions made upon the mind do not, however, equally connect themselves with the idea of matter. Some, of course, do not so connect themselves at all. When we are struck by the generosity or baseness of an action, or feel the influence of character, or experience the pleasure of harmonious or the pain of discordant relations, our consciousness is in no way concerned with matter. There might be no such thing as matter in the world, for aught we know or care about it at such moments. Yet our impressions have the very highest degree of definiteness. But even impressions made directly on our physical senses do not all, with equal force, bring the conception of matter before the mind. The word "phantasm" bears witness that visual impressions do not always convey a belief in the existence of the external reality called matter. It means, literally, "an appearance"; but it has come to mean an appearance void of all substantive reality. There is the same implication when we speak of "rubbing our eyes" to make sure that we see a thing. The sense of hearing is, in like manner, sometimes distrusted; and it may be said that, if we lived in a world in which our only knowledge of objective existence was through sights and sounds, our idea of matter, if we had one at all, would be very different from what it actually is. There is, however, another sense, the testimony of which is held to be surer than that of any other, the sense of touch. Sight may deceive, hearing may deceive; but what we can touch and feel is real. Here we find the true basis of the popular idea of matter—that which can be *felt;* that which resists our muscles. It is true

that in this case, also, we are thrown back upon subjective impressions, or, in other words, upon mental experiences; but these experiences have at once a certain breadth and a certain intimacy about them, which leads us in general to give them the preference, and to make what seems to be the source of them our very type of reality, to which we apply the special name of *matter*.

Considering the subject further, we perceive that sight and hearing are, strictly speaking, specialized forms of the sense of touch—forms so specialized that their fundamental similarity to touch is commonly lost sight of. There is, therefore, no good reason for treating their revelations as less founded on reality than those which we owe to muscular sensation; yet, for all that, matter, to the popular mind, will always be something which directly appeals to the sense of touch.

We may now begin to see what materialism is. Materialism is a form of belief, or mode of thought, which in all things prefers to rest on the evidence of the broadest impressions of physical sense, and which suspects, where it does not deny, the reality of aught that can not be brought to the test of sense-impression. It objects to advancing beyond the primary elements of consciousness; and any steps which it takes in the region of mental or moral phenomena it takes grudgingly and with a constant dread lest it should be led to recognize as real anything that can not be *felt* as we feel sticks and stones. The materialist has to live as other men, and, where his theories are not at stake, he will use ordinary human language as freely as others. He will talk of hope and fear, of love and hatred, of ambition and apathy, of honor and disgrace, of character and motive and principle, as if he knew what he meant, and as if the words he used answered to certain realities of human life. But, once touch his theory, and he will seek to drain these words of all meaning, or else fall back upon vague talk about "modes of matter."

Materialism is the refuge of minds that have been immaturely freed from spiritualism, or perhaps we may more fitly say, spiritism. By spiritism we mean that undeveloped condition of the mind in which hypothetical existences are required at every turn to account for observed phenomena, in which the mind can not bear to be left alone with facts. The child learning to walk holds by its mother's finger; the mind learning to think uses such hypotheses as it can construct, and for physical acts it frames spiritual antecedents. The child who thinks it can walk before it really can, and leaves its mother's finger, finds itself compelled to creep along by the wall. In like manner the materialist who has let go his spirit hypotheses is compelled to creep along by the wall, to rest upon something *hard*, in order to steady his steps. Divert his attention, and he will walk for a while with his hands free; but, remind him where he is, and he totters back in a moment to his tangible support.

The positivist, on the contrary, is a man who has learned to walk

alone. He asks only support for his feet; and *that* he finds in the instinctive confidence in his physical and mental powers, with which, in common with other men, he is endowed. To the positivist a fact is a fact, wherever and in whatever guise he meets it. And all facts stand to him upon an equal level in point of authority. Having learned to dispense with the spirit hypothesis, he has learned to dispense also with bad metaphysics, particularly with the bad metaphysics that lie at the foundation of materialism. He repudiates the idea that a superior degree of reality attaches to *hard* things, and he bewares of drawing the metaphysical conclusion that tangible things constitute the stuff of the universe. A hard thing is well in its way: so is a soft thing; so is an impalpable thing. What the universe is ultimately made of he does not inquire, because he knows the inquiry is vain. He is content with facts, and to him a fact is *whatever produces a complete and definite impression upon the mind.* He does not make his own mind the measure and test of all possible existence, but he holds that it is the measure and test of all things that concern him. There may be things of which he knows and can know nothing, but he indulges in no speculations in regard to these—his duty being, as he conceives, to apply himself assiduously to the knowable order.

To the positivist, I have said, all facts are of equal authority; and, in order to decide what is a fact, and what therefore he should treat as a reality, he merely asks, Is it capable of definitely affecting my mind? Whatever stands definitely related to the mind is a fact, and has all the reality that can be discovered in anything whatsoever. All we can say of a piece of granite is that it definitely affects the mind; we know it as so-and-so. Whether it be, as Mr. Herbert Spencer maintains, but the representation of an unknowable reality, the positivist does not inquire: enough for him that he is able to cognize it under certain definite forms. But what we here say of a piece of granite, which would be the materialist's choice illustration of real existence, we may say equally of an action, a word, a thought, an impulse, a characteristic, a tendency. These are all facts, capable of definitely affecting the mind, and often affecting the mind more intimately and powerfully by far than tangible objects. What is it in my friend that is of most concern to me? His bodily frame? By no means. He could not exist without a bodily frame, any more than he could walk without ground to walk on. But his bodily frame may have nothing in it to please the eye, or in any way to arrest attention. The color of his hair, his weight, or even his stature, might change materially, and the difference to me would be little more than if he had changed his clothes, provided the disposition of his mind, those mental and moral qualities that had won my regard, had remained unchanged. In this case, disposition, a thing wholly impalpable, is of vastly more account to me, as an element in my environment, than the whole assemblage of physical properties and qualities represented by

my friend's bodily structure. Now, the difference between the materialist and the positivist lies just in this, that the former is embarrassed at the decided effects which he sees produced by impalpable things, while the latter escapes such embarrassment entirely, simply by not having set up any arbitrary standard of what constitutes reality. The materialist does not want to recognize anything as real that does not more or less resemble his piece of granite, that does not affect the tactual sense; while the positivist is content to recognize all things as real that reveal their existence to the mind by affecting it in a definite manner. He cordially admits that the piece of granite does this, but he says also that a thousand things that have no analogy with it whatever do it as well.

Some people, chiefly materialists, will heedlessly say that this is idealism. But they are totally mistaken. Idealism consists in affirming reality of the mind and denying it to objective existences, or in affirming that the apparent distinction between subject and object is unreal and illusive. The positivist does neither the one nor the other. He simply abstains from setting up an arbitrary standard of reality. He talks neither of mind-stuff nor of world-stuff; such talk, indeed, he can not help regarding as *all* stuff. He *knows* that he knows and that he feels, and that there are certain definite sources of knowledge and feeling. He perceives that he has an environment upon which he can act, and which reacts upon him. That environment is a very complex one, answering to the complexity of his own nature. There is nothing within him, indeed, that has not some answering element without. Regarding him first as an animal, he has a nutritive system, which has its answering external realities; he has a nervous and muscular system, to which the outward frame of things in like manner responds. Taking a higher point of view, he has intellectual faculties which lay hold of the relations of things in the outer world; he has an emotional nature, with moods that vary according to the nature of the stimulus they receive; he has social faculties and propensities that find exercise in the domain of society; he has powers of moral judgment that recognize, apart altogether from the verdict of society, the essential moral qualities of actions. To each range or level of function in the individual man there are corresponding realities in the outer world; and it is to be observed that what are realities to one set of functions are not realities in the same sense to any other. The nutritive quality of an apple is not a reality to the muscular sense, nor is the weight of the apple which is cognized by the muscular sense a reality to the nutritive function. The test of reality is, we thus see, the existence or non-existence of definite relationship. To illustrate the same form further, we may observe that the physical properties of bodies are not realities to the intellectual faculty that investigates their spatial or numerical relations. The weight of a statue, or the chemical composition of the marble or bronze of which it is made, is

not a reality to the æsthetic sense. The emotional nature finds its realities in the things that kindle emotion, not in those that furnish matter for intellectual exercise or for physical sensation. Who can ever forget those exquisitely simple words of the poet Tennyson?—

> "And the stately ships go on
> To their haven under the hill;
> But oh, for the touch of a vanished hand,
> And the sound of a voice that is still!"

The vanished hand, the silent voice, are here but symbols of a thousand clustering associations dear to the heart in past times, and dear to the heart still. The physical sensation is the *nexus* of things that no physical methods could possibly enable us to understand, things known only to the emotional nature. The touch or the voice that thrills one human being will be wholly indifferent to another—will, in fact, rank only as a mere physical sensation. The heart of a mother would be rent by the cry of her child in pain or in danger; but what would that cry be to a devouring beast? It would have no relation, except as a definite volume of sound, to anything in the beast's nature, and therefore, in all the elements that would speak to a human—to say nothing of a mother's—heart, would be non-existent.

It is, however, when we consider man in society that the range of impalpable realities becomes widest, and embraces facts of the deepest import; and just as society becomes more complex does this truth assume deeper significance. In a society like ours, at every step a man takes through life, he encounters forces as real as those of physical nature, but whose seat is in social institutions and in the dispositions of individual men. There are ambitions, interests, customs, prejudices, conventionalities, and a thousand intangible forms of social force, that all react upon the individual man like so many conflicting winds and currents. The individual can and does react against these, and herein he differs from a wave-tossed vessel; but, steer his course with as firm a hand and as steady an eye as he may, the great composition of social forces will powerfully affect the line of his movement.

The great practical defect of a materialistic philosophy is that it leads its adherents to underestimate all forces and influences that can not be reasoned about as we reason about the laws of matter. The materialist rests by preference on a relatively low plane of thought; and he is at a great disadvantage when he has to deal with matters that lie in a higher plane. But many are materialists in this way who would utterly repudiate materialism in theory. In other words, there are many whose methods of judgment are wholly unsuited (through excess of simplicity) to questions involving the higher human motives, or the less obvious conditions of human happiness. Many a man has made a disastrous business failure through a too materialistic way of looking at things. He wants money, let us say, for his business; he

finds a partner who has money, and the importance which he attaches to this obvious and, so to speak, palpable condition, leads him to overlook the less obvious but equally important conditions of character, compatibility of disposition, and business aptitude. He finds to his cost in a short time that these things should not have been overlooked. Men, again, who have unlimited faith in the power of statute law to work moral reforms are so far materialists. Their trust is really in physical force. The whole school of political economists have helped to cultivate materialistic modes of thought, by making abstractions of all the influences that modify the working of their so-called economic laws. The truth of the matter is, that the moral condition of society at any given time profoundly modifies the whole course of business. Paralyze confidence between man and man, and the whole commercial and industrial world falls out of gear. Restore confidence, and the wheels of exchange once more begin to move. In a thousand ways, that people with materialistic modes of thought are apt to overlook, tangible results depend upon intangible causes, or are governed by intangible conditions. A true philosophy bids us always to try and rise in our speculations to the level of the phenomena with which we have to deal, and always to beware of denying or ignoring the complexity of a problem merely to indulge our intellectual indolence. Materialism, according to Comte's definition, is essentially *the habit of judging things from too low a plane*, and this is the sense in which I use the word throughout this paper. To suppose that any particular grossness attaches to matter is a conception worthy only of the moles and bats of philosophy. Before we could affirm grossness or anything else of matter we should have to get some of it, and compare it with something that was not matter, but which yet could be legitimately compared with it. Until this feat is accomplished, it would be well for all sensible people to refrain equally from praise and from abuse of matter. What there can be no risk of error in assuming is, that the exercise of certain faculties gives us the conception we have of matter, and that the exercise of other faculties gives us mental experiences of quite a different order. The materialist insists upon the convertibility of all experiences of the latter kind into experiences of the former kind. The positivist, on the contrary, feels under no obligation to perform any operation of this kind; and fails to see how he would be advantaged if he could or did perform it. He is content to believe that we are in no less real a world when we are dealing with human affections and passions, with social laws and forces, and with spiritual results in general, than when we are occupying ourselves with things that appeal directly to the outward senses, and that give us our impressions of form, color, and weight.

It has thus, I trust, been made apparent why the positivist would refuse to be called a materialist, and why he would equally object to be spoken of as an idealist. He is the only man, as it seems to me,

who takes the world exactly as he finds it; and who, upon principle, abstains at once from unfounded affirmations, unsupported judgments, and unanswerable questions. His business, as he conceives it, is to regulate his life, and help others to regulate their lives, by *realities;* and a thing to be a reality to him does not need to be a stone-wall.

THE SIRENS OF THE SEA.

By W. H. LARRABEE.

THE sea is inhabited by three families of mammalian animals, which, though they may be so "very like a whale" as to have been sometimes spoken of together as cetaceans, are quite distinct in their structure and habits, and show evidences of distinct origin. They are the cetaceans, including the whales, dolphins, and porpoises; the pinnipeds, including the seals, sea-lions, and walruses; and the sirenians, including the manatees and dugongs. The affinities of the cetaceans are not exactly known, but it is certain that they are creatures of a very different sort from the animals of the other two classes; the pinnipeds are closely allied to the bears, dogs, and cats. Both these classes are carnivorous. The sirenians are herbivorous pachyderms, whose nearest analogies must be sought among the hogs, tapirs, and particularly in the hippopotamus.

The manatee, or sea-cow, is the most widely diffused of the sirenians, and, being American, has the first claim to consideration. Its various species are found along the coasts and in the rivers and inland lakes of tropical America; the length of the entire opposite coast of Africa, around the Cape; and as far north up the Mozambique coast as the Zambesi River; in the upper Niger River; in Lake Tchad; in the East African Lake Shirwa; and in the Tana Sea, in Abyssinia. Agassiz has termed the animal the modern representative of the dinotherium, and it is most probably the creature which Columbus mistook for a mermaid. It grows to be sometimes as long as seventeen or twenty feet, but generally not more than from eight to twelve feet, and to weigh from one to three or four tons, having a body the shape of an elongated barrel, slightly flattened above and below, with two fore-limbs, but no sign of hinder extremities, and an horizontally flattened or spatulate tail of about one fourth the extent of the body. Its skin is much like that of the hippopotamus, and is very sparsely covered with hair. Its fore-limbs are set far forward, are more free in their motions than those of the cetaceans, and may be used as claspers, flexed over the chest, for swimming or dragging the animal along the bottoms, or up the banks of the rivers in which it feeds, and to assist in the prehension of food. The finger-bones may be felt

through the skin, with which they are connected; but no evidence of digital organs is outwardly visible, except the rudimentary nails on the edges of the flippers. The flippers, flexible and possessing much of the power of the hand, have given the animal its name, from the Latin *manus*, a hand. The head is conical, with a fleshy nose,

FIG. 1.—MANATEE.

like that of a cow, and large nostrils, and appears as if joined immediately on to the body, without visible neck. Anatomy furthermore shows that one of the cervical vertebræ, of which there are generally seven in mammals, including the dugong, is wanting. The mouth is small, and without front teeth, but is provided with two mobile, lateral, bristle-covered pads, with which it seizes its food quite dexterously. The mammæ are on the breast, and so resemble those of the human being as to make it easy to believe that the fable of the mermaid was derived from this animal.

The manatees feed in herds on the bottoms of rivers and the shallow waters along the shore, where they browse on algæ and aquatic herbs. They associate together in the most peaceable manner, and show a great community of feeling. They combine for defense when attacked, taking especial care of their young, by putting them in the center of the group, and, it is said, showing so much intelligent sympathy as to try to pull out the weapon from one of their companions which may have been struck with a harpoon. It is, indeed, a great shame to attack them wantonly, for no animal is more gentle and inoffensive, or more easily domesticated; but their flesh is excellent food, being much like pork, and is, moreover, allowed by the church to be eaten as fish on fast-days, and must, therefore, be considered legitimate prey for man. These animals are the most numerous inhabitants, after the turtles, of the waters around Greytown, Nicaragua,

and are actively pursued by the Indians. The largest and best-known species is the Florida manatee, which inhabits the Gulf of Mexico and West Indian waters; the South American species is smaller, and the African the smallest of all.

The dugong is the congener of the manatee in the Indian Ocean and the Australasian waters. It is as large as the manatee, and visibly different. Its head is small in proportion to the body, and is separated from it by a slight but distinct cervical depression; its skull is short, and its snout terminates abruptly in a large, thick upper lip, looking "something like the trunk of the elephant cut short across"; its tail, horizontally flattened, like that of the manatee, is forked or crescent-shaped, instead of being entire, as with its congener; and its flippers are destitute of any traces of nails. The eyes are small, and are furnished with a third eyelid or nictitating membrane. For the rest, we let an English writer, who examined one of the animals at the hunting-grounds in Moreton Bay, Australia, describe him:

FIG. 2.—DUGONG.

"Now I could understand," he says, "why one person had told me the dugong was like a whale; another, that it resembled a seal; a third, that it was not unlike a porpoise. The animal was in some sense a reminder of them all, but really not to be compared with either. It was, perhaps, likest a seal of elephantine proportions; and a baby dugong that had been taken from one of the prizes over which the carrion-birds were fighting and squabbling, and that had been kept for dispatch in spirits to England, would very well pass for a member of the seal family. A tour round the mature specimen had to be twice repeated before I could see my way to a clear comprehension of its 'points.' Its dull-brown body was like a large cylinder, tapering off toward the head and great paddle-shaped tail. Ears there were none to speak of. The eyes were tiny, and three parts buried. The two flippers, considering the size of the animal, were remarkably small. The most prominent feature was the head, which terminated in a solid, square-cut upper lip, that warranted its comparison with a bullock. Being a female dugong, there were neither teeth nor tusks in the upper jaw, but a couple of small tusks of good ivory had been that morning taken from one of the bulls already operated upon. The inside of the mouth was lined with a rough apparatus, like a worn-down scrubbing-brush. The dugong, in short, is a vegetarian of the strictest order;

and the stomach of our dead friend contained an immense quantity of vegetation cropped during the night from the bottom of the sea. It was the most curious example of a ruminating (herbivorous?) mammal I had ever seen. The skin was bare and slightly wrinkled, though at a distance it appeared to be quite smooth."

The dugong's nostrils are displayed upward; its lips have a horny edging which assists it in tearing sea-weeds from the bottom; and the forward part of its snout is covered with soft papillæ and a few stiff bristles. It often comes to the surface to breathe, and utters a peculiar cry, which our English writer, who heard it, describes as "a plaintive appeal, as if a child half awakened had softly moaned, and turned over to sleep again. I looked around," he adds, "in time to see a clumsy, grayish-brown head silently thrust above the surface, and, without leaving a sign, as silently disappear."

This animal has become the object of a thriving industry, the chief seat of which is at Moreton Bay, Queensland. Every part of the creature is marketable, and the pursuit and capture are easy and safe—too much so, probably, for the permanence of the trade. The flesh is eatable as beef, veal, or bacon, either of which it may be made to resemble; the head can be cooked into a delicious brawn; the flippers, a good deal boiled, make capital soup; the bones are dense, close-grained, and capable of taking a high polish, hence adaptable to a variety of uses; the ivory tusks are in request for knife-handles; the skin is good to make a jelly "as acceptable and beneficial to invalids as calf's-foot," and for leather; and the fat is rendered at Moreton Bay into a palatable and wholesome oil.

The dugong-hunting season at Moreton Bay, where the animals are supposed to resort from tropical seas to give birth to their young, lasts through the winter weather. The submarine pastures upon which they feed, says a writer in the "Gentleman's Magazine," "lie at a depth of from eight to fourteen feet, and the favorite grounds are banks protected from the sea, in bays and straits. They graze in company, and feed down the herbage so close that they leave a well-defined track to indicate their movements. The black fellows, who love occupation of this kind, if any, peer over the gunwale of the whale-boat into the clear water, and are unerring authorities, telling at once when the monsters passed that way though it were a week previously, and giving a shrewd guess as to their present whereabout." The animals are then tracked up, and strong nets, presenting a wall specified in one instance as fourteen feet high and a hundred and fifty yards long, are placed so as to intercept them as they go browsing up to their feeding-grounds. The dugong, in happy innocence, eats greedily of the succulent growths, clearing its way in the most workmanlike manner, when it is suddenly stopped by this strange barrier. Being a remarkably timid creature, it takes fright, loses its presence of mind, and gets hopelessly entangled. "Now and then a dugong is found

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wrapped round as with the folds of a hammock, and the net has to be cut away piecemeal. As often as not, the dugongs thus drown themselves by frantic efforts to escape, but where a partial entanglement permits them to follow their instinct and come to the surface, they are taken alive. In the morning the boat cruises round to see how the nets have fared and to secure the game. . . . The dugongs that are found alive in their captivity struggle desperately. As a rule, they are as harmless as vegetarians are usually supposed to be, the only known breakers of the peace being a couple of bulls fighting over a sweetheart, or a frantic mother maddened by danger to her offspring. Nevertheless, although the dugong is by nature mild-mannered, and innocent of the wiles by which a Greenland whale sends a boat spinning into the air with all hands, the men prefer to give the netted individual a wide berth. Nor would it be the correct thing to slaughter it on the ground, lest the blood should attract a legion of sanguinary sharks, whose attacks would cause a speedy loss of the booty. The dugong, still floundering, is therefore hauled ashore, and a long knife applied to the throat puts an end to its career." Harpooning has been practiced, and is much liked by the blacks, but is discountenanced because it tends to drive away the animals.

"When the dugong was hauled up on the sandy slope, a line was cut down the belly and the skin was taken off in one piece, and spread out to be used as a receptacle for the meat as it was hewn from the carcass. As it happened to be a fair-sized skin, it required two men to carry it. We were afterward shown a hide that was an inch and a half thick at the back, though the thickness had gradually diminished toward the under part of the body." The hide is not, however, composed of gross material, but is really quite delicate.

The flesh "is cut off the carcass in flitches and slabs, and from the same animal is taken meat resembling beef, veal, and bacon. I have eaten it in each form, and can testify to its excellence, and to the way in which it has been palmed off upon knowing men as prime fillets of beef, cutlets of veal, and rashers of superior bacon. If the dugong is not properly fat, it is turned chiefly into bacon; should it, however, present a layer nearly two inches thick, the snow-white fat is used for a more important purpose. The lean flesh, beef-like in the mature and veal-like in the young animals, is eaten fresh or salted for food. The bacon-flitch in size, color, and streakiness, if hung in an English pork-butcher's shop, might easily be taken for a section of the side of a true Wiltshire hog; and the only difference detected in the eating would be, in the dugong, an absence of the strong flavor too often found in pork; and a mature dugong, twelve feet long, or thereabout, would weigh nearly a ton. It is worth mentioning, too, before passing from the flesh of this animal, that the meat from the calf is always the best, and that it is recommended by the faculty to consumptive persons, by reason of its undoubted strengthening qualities."

The oil, which is extensively manufactured at Moreton Bay, possesses all the medicinal qualities of cod-liver oil without its unpleasant taste. In its pure state it can be taken without disagreeing with the most sensitive stomach. "I have myself," says our English writer, "used it instead of butter with toast; have eaten delicate pastry made from dugong-lard; have fried fish with it; and, as a consequence, have never since ceased to wonder that some better effort is not attempted to make it more widely known. Consumption, the scourge of the old country, finds an unfriendly atmosphere in Queensland, where I have known consumptives, landing with the disease to all appearance hopelessly advanced, become in a few years healthy if not robust, yet, even there, the most marvelous effects are attributed to dugong-oil in cases of rheumatism, and wasting as well as ordinary consumption. . . . I have known ladies, who shuddered at the bare notion of swallowing oil, derive benefits from its adaptation to all manner of culinary purposes."

Dr. Hobbs, of Brisbane, who first introduced the oil, received a medal at the Paris Exhibition of 1855 for his product. The manufacture afterward fell into other hands, and the short-sighted managers, rather than admit that the supply could not be equal to the demand, adulterated the pure product with unsavory shark-oil. Then they were astonished and indignant that they received no more orders from the old country.

Because the sirenians live in the sea, the first inclination of naturalists, before they had become fully acquainted with the family, was to classify them with the whales. A better knowledge of them has proved that this arrangement, unless it is safely qualified, is misleading. Professor Owen says on this subject: "The whole of the internal structure in the herbivorous cetacea differs as widely from that of the carnivorous cetacea as do their habits; the amount of variation is as great as well could be in animals of the same class existing in the same great deep. The junction of the dugongs and manatees with the true whales can not, therefore, be admitted in a distribution of animals according to their organization. With much superficial resemblance, they have little real organic resemblance to the walrus, which exhibits an extreme modification of the amphibious carnivorous type. I conclude, therefore, that the dugong and its congeners must either form a group apart or be joined with the pachyderms, with which the herbivorous cetacea have most affinity."

Professor H. C. Chapman, of Philadelphia, who has dissected a male and a female hippopotamus, has discovered several analogies in structure between the manatee and that animal. He remarks that in observing the manatee that lived for several months in the Philadelphia Zoölogical Garden, the manner in which it rose to the surface of the water to breathe reminded him often of the hippopotami that he had watched in the Zoölogical Garden of London and the Jardin des

Plantes in Paris. The slow way in which the animals rose to the surface, the motionless poise of the almost sunken body, the nostrils often just appearing at the surface, were very much alike in both animals. The stomach of the manatee resembles that of the hippopotamus in an atrophied condition; the sexual vesicles are found in both the hippopotamus and the manatee; the placenta of the hippopotamus offers points of resemblance with that of the dugong; and the brain of the hippopotamus, besides its typical relations to those of the pachyderms and ruminants, has also affinities with that of the manatee. "Beginning with the pig, we pass by an easy transition to the peccary, which leads to the hippopotamus, and thence, in diverging lines, to the ruminantia on the one hand and the manatee on the other. Paleontologists have not discovered a form which bridges over the gap between the hippopotamus and the manatee, but it will be remembered that certain fossil bones, considered by Cuvier to have belonged to an extinct species of hippopotamus (*H. medius*), are regarded by Gervais as the remains of the *Halitherium fossili*, an extinct sirenian, of which order the manatee is a living representative. . . . I do not mean to imply that the manatee has necessarily descended direct from the hippopotamus, though extinct intermediate forms may in the future show this to be so, for possibly they may be the descendants of a common ancestor. . . . It seems to me, however, that the only explanation of the structure of the living forms, and of the petrified remains of the animals referred to in these observations, is the hypothesis of there being some generic connection between them." Some writers have regarded the dugong as the behemoth of the Scriptures, which ate grass like the ox, and whose bones were as bars of iron, although the identity is more frequently ascribed to the hippopotamus. Since they are both so much alike, either animal will do. "It is true," says our English writer, "that the dugong does graze on submarine pastures, and that his bones ring as hard as steel when struck; but the reference might be held to apply equally well to the *Halicore tabernaculi* of the Red Sea, which bears a rough resemblance to its Australian relative."

Rüppel has suggested that the curtain with which the Israelites were ordered to veil the tabernacle was made of the skin of the dugong; but it is hard to imagine how a hide an inch thick could be adapted to such a purpose.

Another member of the family of the sirenians (*Rhytina stelleri*) was found by the Russians in Behring Strait in 1771. The mariners of Behring's second expedition, who were shipwrecked there, lived principally off its flesh for nearly a year. It is said that the animal was so hotly pursued afterward by hunters that it was exterminated in seventeen years, and no specimen has been seen since. Baron Nordenskiold, however, in his "Voyage of the Vega," adduces evidence to prove that a specimen of this animal was seen twenty-seven years

ago, although there is little doubt that it is now extinct. The Baron, moreover, does not believe that its extinction was due to destruction by the hunters, but that it was a survival from a past age, doomed to

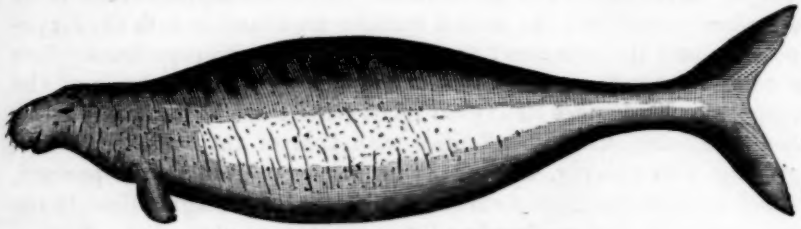

FIG. 3.—RHYTINA STELLERI, RECONSTRUCTED.

extinction, which overtook it when it was driven from its pastures on the shore of Behring Island. It attained a length of twenty-five feet, and had a skin composed of horny tubes, sometimes an inch long, wrinkled like the bark of a tree, which served to protect it from the ice and rocks on which it fed. It had no teeth, but its jaws were covered with an undulating surface of horny, tubular matter; and it was a vegetable-feeder, resembling in habits and qualities the other members of the family.

THE MACHINERY OF ELECTIVE GOVERNMENT.

BY PROFESSOR GOLDWIN SMITH.

IT is not necessary, for the purpose of this paper, to enter into any comparison between hereditary and elective government. Manifest it is that the era of elective government has come. In the communities of the New World, the latest development of humanity, the hereditary principle, has failed to take root; the monarchy of Brazil being merely a European dynasty in exile, the life of which hangs by a thread. In the Old World dynasticism is plainly in a state of decadence, the forms surviving longest, as might have been expected, where the substance had been most completely abolished. The era of elective government has come, and in the wise ordering of it, so as to give public reason the upper hand, and to reduce as far as possible the influence of passion, class interest, selfish ambition, faction, and corruption, lies the political hope of the world. If hereditary monarchy and aristocracy are dead or doomed, dead also is the light hope of the Revolution that all the evils of government would be swept away and the reign of reason and justice at once opened, if only monarchy could be overthrown. The divinity of the people has proved almost as unlike reality as the divinity of kings. It is time that the form of government should, if possible, be settled, and the political revolution

brought to a close; the prolongation of the struggle, with all the appeals to passion and other sinister motives which it involves, is seriously affecting character and collecting difficulties round the government of the future, while a deeper and more momentous revolution, in the religious and social sphere, threatens the stability of civilization, and demands with increasing urgency the attention of the world.

It is needless to say that the forms of government are not all. Constitutions, however wisely framed, will not work without political character; nevertheless, constitutions are most important, and their influence in forming political character is not small. The adoption of elective government in any shape implies of course that the people have arrived at a certain stage of intelligence and self-control. In what are called the South American republics the attempt to introduce elective institutions among Spanish creoles and Indians has totally failed, and the result is a series of dictatorships, the offspring of usurpation, which are little better than leaderships of a human herd. A sudden introduction of elective government into Russia would, in like manner, probably result in anarchy. On this subject the world has received lessons which reaction has exaggerated to the extent of almost denying the usefulness of wisely ordered institutions, as though blind habit and prejudice alone were trusty guides, and reason, sovereign in all other spheres, were excluded from the highest.

Strict definitions of government and enumerations of its functions are of little value. It may be described, practically, as the organization of the community for such objects as are best attained by common action; a definition which will include national defense and protection of life and property always, but also such other objects as circumstance and the conditions of the nation internal or external may from time to time suggest: centralization being at one time good, while, when a system has been set on foot and the people trained for it, the moment for decentralization may arrive, individual action being as a rule preferable because it calls forth more public virtue and raises the character of the citizen.

In such a paper as this, all that can be done is to present the chief points as they have been brought before the writer's mind by seeing the working of elective government in three countries—Great Britain, the United States, and a British colony. This object will be secured even if none of the writer's opinions, which are stated with unavoidable brevity, should commend themselves to the reader.

The chief points are party government, the expediency of a second Chamber, the mode of electing the Legislative Assembly, the constitution of the Executive, and the franchise. The consideration of these at least suffices for the present. On the horizon there are perhaps symptoms of a still greater change. Parliaments are losing much of their importance, because the real deliberation is being transferred from them to the press and the general organs of discussion by which

the great questions are virtually decided, parliamentary speeches being little more than reproductions of arguments already used outside the House, and parliamentary divisions little more than registrations of public opinion. It is not easy to say how far, with the spread of public education, this process may go, or what value the parliamentary debate and division list will in the end retain. If monarchy is primeval, parliaments are the offspring of the middle ages, and for them too the sand in the hour-glass of history runs. But this is a problem which belongs to the future.

At present party it is that governs, though under different sets of forms. In England it governs under the forms of King, Lords, and Commons; in the United States under the forms of President, Senate, and House of Representatives, together with the State Executives and Legislatures. In England and the United States alike it is supreme. It elects the members of all the Legislatures, since it controls the nominations, without which no candidate can go with a chance of success to the poll. It appoints the executive, which is a committee of its leaders, and the composition of which always depends on the fortunes of the party conflict; it supplies the working organization of the Legislature, a reorganization of which in England or elsewhere will be attempted in vain without a solution of this preliminary question. Why is it that the work of De Tocqueville, with all its philosophy and its literary beauty, is practically so little instructive and so seldom quoted in the United States? Because he studied the forms, not the forces, which are the parties. Why is it that the Senate of the United States, designed specially to embody the federal principle, while the House of Representatives embodied the federal and national principle, has not corresponded in action to that design? Because the same parties control both Houses and the State government at the same time. Congress, in truth, is now little more than a place for formally ratifying and recording the decisions at which the party having the majority has arrived in caucus, where the only real deliberation takes place. As the minority in caucus is bound by party law to vote with the majority in the legislative hall, it often happens that a small minority of the whole Legislature passes a law or carries an election. Take away party, and we see that the whole of the present system of parliamentary government would crumble. We have, then, at once to ask what party is; upon what basis of reason or public morality it rests, and whether it can last. Burke says:

> Party is a body united for promoting by their joint endeavors the national interest upon some particular principle on which they are all agreed. For my part I find it impossible to conceive that any one believes in his own politics or thinks them to be of any weight who refuses to adopt the means of having them reduced into practice. It is the business of the speculative philosopher to mark the proper ends of government. It is the business of the politician, who is the philosopher in action, to find out proper means toward those ends, and to employ

them with effect. Therefore every honorable connection will avow it is their first purpose to pursue every just method to put the men who hold their opinions into such a condition as may enable them to carry their common plans into execution with all the power and authority of the state. As this power is attached to certain situations, it is their duty to contend for those situations. Without a proscription of others, they are bound to give to their own party the preference in all things; and by no means for private considerations to accept any offers of power in which the whole body is not included; nor to suffer themselves to be led or to be controlled, or to be overbalanced in office or in council by those who contradict the very fundamental principles on which their party is formed, and even those upon which every fair connection must stand. Such a generous contention for power on such manly and honorable maxims will easily be distinguished from the mean and interested struggle for place and emolument. The very style of such persons will serve to discriminate them from those numberless impostors who have deluded the ignorant with professions incompatible with human practice, and have afterward incensed them by practices below the level of vulgar rectitude.

Such is the vindication of party by a public man who himself broke away from party, outraged connection, and vainly attempted to disguise his secession by an appeal from the living Whigs to the Whigs who were in their graves. It clearly implies that the community is divided by a difference of opinion, not only on ordinary matters and points of current administration, but on some question of fundamental character and of paramount importance. Nothing less can make the submission of the individual intellect and conscience to party discipline rational or moral. In the absence of such a question, party is faction, the ruin of all commonwealths. Is the stock of such questions inexhaustible? In Canada it is already exhausted, and the two parties there are simply two factions, fighting for place with the usual weapons, and poisoning the political character of the people in the process; no man of sense cares a farthing which of the two, as a party, is for the time being in the ascendant; but every man of sense perceives that if the faction fight continues to rage much longer it will bring disaster on the country. As the earth—according to astronomers—sees in her satellite, of which the atmosphere is exhausted, what her own eventual condition will be, so England may see in her colony what her party government will be when the list of organic questions comes to an end. In the United States, party had its origin in the conflict between Federal unity and State right; then slavery sheltered itself behind State right as a rampart against legislative abolition, and the party conflict raged on the double issue with increasing heat, till it burst into the flame of civil war. Now, though the memory of the war lingers, though there is still a feeling that its issues may possibly be revived, though the negro's liberty of suffrage remains a subject of contention, though a solid South is the core of the Democracy, the parties are evidently breaking up. In each of them, particularly in the Republican party, there is a split wider than the interval of opin-

ion which divides the two parties from each other. Civil-service reform, the burning question of the hour, divides the Republicans into two bitterly hostile sections, while it unites the reform Republicans to the reform Democrats; and free trade, the question next in importance, though less burning, is equally regardless of the party lines, the Republicans of the West being commonly free traders, while among the Democrats of Pennsylvania there has always been a protectionist element strong enough to prevent the party as a whole from moving effectively in favor of free trade. Thus in the United States too, the death of party as a connection sustained by distinctive principle, and the survival of mere faction, seem to be in sight. In England, no doubt, there are still organic questions, such as the extension of the franchise, the Established Church, and the House of Lords; yet even in England the symptoms of dissolution have begun to appear, and in the last century there was an interval of political stagnation during which the party system degenerated into a struggle for power carried on between unprincipled connections with the usual accompaniments—intrigue, calumny, and corruption.

There are some, including grave historians, who fancy that party has its everlasting source and justification in a natural line dividing the political temperament of mankind. But can anybody seriously maintain that a thing so multiplex, varied by such infinite shades, and so mutable, even in the individual man, as temperament, is capable of this sharp and permanent bisection? Can any instance be named in history of a party founded on temperament, not on interest or connection? In politics, as in other things, age, no doubt, as a rule, is cautious, and youth hopeful; yet what reactionists are more violent than the younger members of an aristocratic faction? Is not this evidently a theory of human nature constructed to underprop a falling system? And be it observed that, to make the system work, there must be two parties, and two only. If parties multiply, as multiply they do, and will do in increasing measure, parliamentary anarchy must ensue, and the Government will be left without a sufficient basis. In France the number of fractions, each of which is really a separate party, has for some time past rendered ministries rickety and short-lived. In Italy, to give Government a sufficiently broad foundation, a double ministry, the Cairoli-Depretis, was formed, but with no satisfactory result. The German Parliament is split into at least six parties, not one of which has anything like a majority. In England the unity of what is called the Liberal party, and with its unity its ability to sustain a government, are now in great measure lost, as would appear at once if the commanding influence of its present chief were removed. The Tory party preserves its solidity, but this is because it is a party of interest, the tendency of which is always to unite, while the tendency of opinion is to divide, and to divide in proportion to the activity of intelligence and the amount of moral independence; so that one necessary result

of the system is to give class-selfishness a great and ever-increasing advantage over patriotism and conviction. The quicker the intellect and the stronger the conscience of the nation become, the less practicable will be the mode of government which we are told is alone possible, and destined by an inherent necessity of human nature to endure to the end of time.

Even in its best estate, when there are organic issues, issues which create genuine enthusiasm and raise the combatants above the meanness of faction, is party a good government? Is not the possession of power and place always present as a motive warping the conduct of the leaders on national questions? Does not sheer passion always rage among the rank and file? Is not corruption an almost indispensable instrument of party organization? The bribe may be money, it may be patronage, it may, when the support of rich men is to be gained, be titles and social grade; but is not bribery in some shape always there? Let the main object of association be ever so important, must there not be always, to preserve discipline and beat the enemy, a terrible sacrifice of conscience and of freedom of opinion? Is not legislation, on the most vital subjects, apt to be governed, not by regard for the public good, but by the exigencies of the conflict and the necessity of keeping up the ministerial steam, or raising an agitation to drive opponents from power? It was not an American adventurer, but a British nobleman of ancient lineage and enormous wealth, the vaunted pattern at once of the Conservative sentiment and the personal honor which is supposed to go with aristocracy, who was ready to take such a leap in the dark as household suffrage for the purpose of dishing the Whigs. At this moment is not party trying to cut the sinews of a government which is struggling against a great public peril? It is scarcely possible for statesmen under such a system to give their best energies to the work of legislation and government; their minds must be constantly occupied with strategy, and they are now being called upon in this country, by the increasingly demagogic character of their position, to spend their parliamentary vacation, not in recruiting their working powers and storing thought, but in the delivery of stump-speeches. Stump-oratory is, indeed, in a fair way to supersede statesmanship, for the masses who are now enfranchised care comparatively little about great questions; they want a leader who will fill their imaginations: this a striking stump-orator does, and to him, therefore, though in every essential respect he may be the worst of pilots, the helm of state is likely to be consigned. Perhaps even his influence will be less pestilent than that of the master of tactics and intrigue. Party has served its purpose in history; it has been the rough and questionable, yet perhaps indispensable instrument of progress in England, the agency by which, through a long and intermittent series of struggles, the supreme power has been transferred from the Crown to Parliament,

and from the House of Lords to the House of Commons; but to rest in it as the permanent form of government would be to proclaim that the final state of society is unarmed civil war—civil war unarmed, yet with a perpetual liability to become armed, as it did in the United States twenty years ago. Combination for the attainment of particular objects or reforms, whether political, moral, social, or sanitary, is of course an undying necessity; but it is limited by the object sought; it involves no submission to conscience, nor even of the understanding except in the choice of means; it does not corrupt; it need not inflame; it furls its standard and disbands when the battle is won. As to connection, what Burke's ideal of it was he best could tell; what it was in the flesh we learn plainly enough from the parliamentary history of his time. But neither combination nor connection, in any moral and rational sense of the term, has anything to do with a system of government which perpetually sets up the great offices of state as the prizes of a contest between two organized factions, to one of which each citizen is bound to adhere, owing to his party an allegiance in fact higher than that which he owes to his political conscience or to the state.

It is almost killing the slain, otherwise we might ask in conclusion, supposing the whole community to be convinced of the wisdom and justice of a certain course of policy, is a moiety of it still to take the wrong side for the purpose of keeping up the balance of party forces without which the party system can not subsist; without which, in truth, a party government becomes of all governments the least responsible? Such an agreement as would be fatal to the standing organization of civil discord is by no means out of the question; to it tends the advance of political science and of the scientific spirit generally, which, gradually making its way in all spheres, is not likely to leave politics untouched. In England at this moment the nation at large is Liberal, though in various degrees, and pretty well united in favor of the modern and against the mediæval principles of government; while the continuance of a division depends mainly on the existence of one or two special interests, such as the territorial aristocracy and the beneficed clergy of the Established Church. In fine, as has already been said, the best and indeed the only possible form of government, if the advocates of party are to be believed, is one the foundation of which must inevitably be weakened by every advance of the public intelligence, and which the attainment of truth on the great political questions will bring utterly to the ground.

What, then, is the alternative? The alternative, supposing the elective principle to be accepted, is obvious. It is the regular election of the Executive Council by the members of the Legislature. This would be simply the elective counterpart of the Privy Council, appointed under the monarchical system by the king, which is still the legal executive of England. Renewal by installments would keep the

Executive Council always in sufficient harmony with the Legislature. But the Legislature and the Executive would be set free each of them to perform its proper functions. The Legislature would no longer be hampered by the fear of overturning the Executive; the Executive would be stable, and would discharge the duties of administration and police steadily and without fear about its own existence. At present in France, executive government, the sport of factions and of sections of factions, is utterly unstable, and can hardly assure the necessary protection to the citizen, much less engage his full confidence and his hearty allegiance. No longer would half or more than half the public men of the country be employed in propagating discontent, or a moiety of the nation be in a state of moral insurrection against the government which ought to be the object of its united loyalty and support. It is true that the criticism of an organized opposition would be withdrawn, but that criticism is always passionate and unjust; it is, in fact, not criticism but attack; and the fullest opportunity of fair criticism in an open Legislature would remain. Of the bribery, whether coarse or refined, which is now employed to hold together a following, there would be no need, the tenure of office being secured by law. Under such a system evil motives and influences would not be excluded; they can not be excluded from any system founded on human nature; but they would not be an inseparable part of the polity, and their sway would be diminished by every improvement in the political character of the nation.

Responsibility would not be impaired, inasmuch as an office would be intrusted to each minister only for a term, after which he would have to answer for his conduct, while the Legislature would retain the power of censure, and in extreme cases of impeachment and removal. There would be no majority to vote black white under a false sense of honor for the purpose of shielding a criminal of its own party. The election of the Executive by the Legislature is the natural application of the elective principle of government. Nor can it be said to be wholly novel. It has been tried in Switzerland, though it is true that Switzerland being not merely a nation with a federal structure like the United States, but a union of really different elements, German, French, and Italian, her case is peculiar, and her example must be used with caution. It may be said to exist, though in an irregular and objectionable shape, in England, since the ministry is virtually designated by the vote of the House of Commons.

Another advantage of the regular election by the Legislature to the offices of Government might be the choice of ministers with reference to their departmental aptitudes, in place of the pitchforking system which the necessity of finding places for all the leaders at present entails. Nor need there be much fear of want of sufficient harmony in a board which would have common administrative duties, common pride in their successful performance, and the union

of which would not be tried by differences of opinion about measures of legislation. The state would not be deprived, as it is now, of the services of a first-rate administrator, say of finance or of foreign affairs, because he happened to be in the minority on some legislative question. It is very well for Burke to say that men of the other connection are not to be proscribed; but proscribed under the party system they are and must always be.

Ought there to be a second Chamber? That there ought, is an article of the political creed formed on a supposed inspection of the British Constitution. Imitation of the British Constitution, without discriminating between forms and realities, has led Europe a strange dance. Great Britain can hardly be said to have a constitution in the proper sense of the term. She has a series of enactments, from the Great Charter to the Bill of Rights, limiting the power of the Crown and securing the liberty of the subject. Apart from this she has nothing but a balance of political forces, determined by a long struggle, if balance it can be called, when the political power of the Crown has been reduced almost to nothing, and that of the Lords to a fragment of what it once was, since they can make no permanent stand on important questions themselves, though a stand may be made by the representatives of their order and interest in the House of Commons. There are traditions, no doubt, which in England herself have been fixed by long practice and handed on by a group of political families, notwithstanding which some important points, such as the rights of the House of Commons with regard to the approval of treaties, are still in an unsettled state; but out of England these traditions fail, and, when Canada is set to govern herself according to "the well-understood principles of the British Constitution," it soon appears that these principles are not so well understood, or at least not so religiously observed, by colonial politicians struggling for place, as by the members of the Carlton and the Reform Club. The written constitutions which all the nations of Europe have framed for themselves embody the forms not the realities of parliamentary government in England. They give the appointment of ministers to the king; the consequence of which, in Spain for example, is that the stress of the struggle for power rests just where British practice forbids it to rest, that is to say on the Crown; and every change of ministry is accomplished by an intrigue of the palace or an insurrection. A group of conspirators forces itself upon the monarch, and then, there being no political life in the nation, nominates a Parliament of its own followers, sometimes so far forgetting constitutional decorum as entirely to leave out the opposition; and this is called an adoption of the British Constitution.

The House of Lords has been everywhere taken for a second Chamber or Senate. It is nothing of the kind. It is one of the estates of the feudal realm, reduced by the decay of feudalism to comparative impotence, such influence as it retains being that, not of legislative au-

thority, but of hereditary wealth. It has never acted as what it is imagined by the political architects of Europe to be, an Upper Chamber revising with maturer wisdom and in an impartial spirit the hasty or ultra-democratic legislation of the more popular House. It has always acted as what it is, a privileged order in a state of decay and jeopardy, resisting as far as it dared each measure of change, not political only, but legal, social, and of every kind—*habeas corpus*, reform of the criminal law, abolition of the slave-trade, and a cheap newspaper press, as well as extension of the franchise—because change in whatever line threatened directly or indirectly its own existence. So far from being a Senate, it deliberately declared that it was not and would not be made a Senate, by refusing to let a life Peer take his seat.

The Upper Chamber or Senate is of course intended to have a character of its own distinct from that of the Lower House, otherwise the institution would be futile. The House of Lords has a distinct character with a vengeance, and shows it on all occasions ; but this nobody proposes to reproduce, modern society having decidedly pronounced both against hereditary legislation and entailed estates. What, then, is the distinction to be? Of what special elements is the Upper Chamber to consist? This is what no political theorists tell us, while they all busy themselves in devising modes of appointment or election. Whether this or the other mode of production is the best, it is impossible to judge, unless we are told what is the thing to be produced. Is the Senate to be a house of old men? If so, it will have the weakness of age, it will be ridiculed and despised. Is it to be a house of the rich, that it may specially protect the interests of property? If so, it will be odious, and expose to political as well as social attacks the very interest which it is set to guard. Is it to be a house of superior wisdom and character? If so, the popular house will be bereft of its natural moderators, and delivered over to the passion and impulse which it is the object of the institution to control, while, its voice being the more direct expression of the national will, it is sure, in any collision, to carry the day. This was seen in the case of Cromwell's attempt to relieve his government from the stress of conflict with the House of Commons by reviving the Upper House, the only result of which was that the Lower House was left leaderless, and the two fell foul of each other. The very existence of an Upper Chamber is found, in the United States for example, to increase the recklessness of the Lower Chamber, which feels itself at liberty to do what is popular at the moment, leaving it to the Upper Chamber to prevent mischief by the exercise of its veto. A Senate nominated, as is that of the Dominion of Canada, by the Executive, besides being an outrage on elective principle, is a nullity, though with a lurking possibility of misuse under the party system and in a country where politics are fierce and constitutional tradition weak, as was seen when the Provincial Senate of Quebec was used for the purpose of a sort of *coup*

d'état by a party which wanted to drive the Government to a dissolution. Any notion that a nominated Senate will be the serene abode of high character, or special knowledge, or commercial authority, such as shrinks from electoral contests, is belied by the experience of Canada, where the Senate is a mere infirmary for superannuated partisans, especially for such as have spent money for the party elections. Where the Senate is elective, and the authority of the nation is divided, in whatever proportions, between the two Houses, collision is certain to ensue, sooner or later; as it has in Victoria, as it did in France when, on the famous 16th of May, the country was in this manner brought to the verge of revolution. Collision is not the calm review of legislation, nor has it any tendency that way; its tendency is to political convulsions. Political convulsions are the almost inevitable result of an attempt to divide the national will and to make it manifest itself through two independent organs, sure soon, if it were only from corporate jealousy, to become antagonistic. Where harmony has been preserved, it has been due to the ascendency of the same party in both branches of the Legislature, a condition of things which is always precarious, while, if what has been said of the party system generally is true, that system can not be relied on as the sustaining or controlling force of any polity for the future. The whole theory of mechanical checks and balances, however consecrated, is unsound; it belongs to the times of jealousy between monarchs and their subjects; the hope of a commonwealth lies in the more genial policy of disposing all its members to the common good. Methods of securing deliberate action may be devised in the interest of all; but no ingenuity can really devise a method of permanently dividing the national will and making it check itself.

To secure deliberate action, the first thing necessary is to have the wisest men of the country in that assembly which represents the will of the nation. But haste may be also prevented, and time given for reflection and for change of mind, by arrangement of the forms of legislation. It might be desirable even to confer a suspensive veto for a short period on a stated minority. Such an expedient would at least be more effective than the obsolete veto of the Crown, and less disturbing to the political frame than a collision between the Commons and the Lords, out of which the only way is a coercive dissolution of Parliament in the midst of a boiling agitation, or a swamping creation of Peers.

The question whether an individual chief of the state is necessary concerns most the American Republic. It is at present complicated by the exigencies of party, which requires a chief—as an army requires a general—though such a minister as Lord Aberdeen was hardly more than the president of a council. In Switzerland—an example which, for the reason already given, is always to be cited with reserve—there is only a titular President of the Federal Council,

without personal power or a prominent place in the minds of the people. The belief in the necessity of an individual chief seems to be a tradition of monarchy. In framing their institutions the founders of the American Republic, though they substituted election for inheritance, and introduced the federal element, were guided by the principles which Montesquieu and other political philosophers of the time supposed themselves to have educed from the practice of the British Constitution. In the place of the king, whom they imagined to be the real ruler, though he had already become a figure-head, they put an elective chief magistrate, and they jealously guarded what they had been taught to regard as the palladium of liberty, the separation of the executive from the legislative, though, had their eyes been strong enough to look through the haze of constitutional fiction, they would have seen that the Legislature in England was all the time appointing and removing the executive, and appointing and controlling the judiciary to boot. The elective presidency is an almost unmixed evil, and an evil of the most formidable kind, especially since the multiplication of patronage has enormously augmented the magnitude of the prize and the number of the place-hunters whose fortunes are staked on the election. It involves the commonwealth perpetually in troubles like those of a disputed succession. It fills the country with the turmoil of a contest which now extends over at least two years of every four, and disturbs commercial and industrial as well as public life. It keeps party passions always at fever-heat. It breeds ever-increasing swarms of wire-pullers, intriguers, office-seekers, and political vermin of all kinds. It brings every dangerous question to a head; it did this in the case of the slavery question, which, in the absence of the artificial crisis produced by a presidential election, might possibly have dragged on and found a gradual and peaceful solution. A dispute as to the result of the election is always possible; it occurred between Hayes and Tilden, and then, too, infuriated partisans began to lay their hands on the hilts of their swords, though the good sense of the nation at last prevailed. Finally, the position of an elective President with personal power, but holding office only for a term, is a standing incentive to encroachment. The ambition of an ex-President, excited in this way, is now riding the country like a nightmare; and nobody can doubt that the aim of the men about him is to place him in the office for life, an object which, if they succeed in again re-electing him, they will not be unlikely to attain. That the people of the United States will ever with eyes open revert to the hereditary principle can not be believed by any one who has not persuaded himself that hereditary government is an everlasting ordinance, to which all who have strayed from it are sure to come back in time. But a lapse into a dictatorship, and from a dictatorship into something like a dynasty, would not be utterly impossible, if the foreign element, untrained to self-government, should become proportionally too large,

and serious troubles of any kind should at the same time arise; it would be very far from impossible, if, in addition to the foreign element, female suffrage should be introduced. Nothing is really needed, at least in ordinary times, but a titular President of the Executive Council to represent the commonwealth on occasions of state. In the civil war Lincoln was, perhaps, useful as a chief, holding by tacit consent a sort of dictatorship during the season of peril; but institutions are not made for civil war, and a provision might easily be framed enabling the Legislature in case of great public peril to confer on the executive council increased authority for a limited time, somewhat after the fashion of the Roman dictatorship, which worked well enough during the healthy period of the republic.

Now comes a momentous question. Ought the election to the central Legislature by the people to be direct or indirect; in other words, ought the members of the central Legislature to be elected by the constituencies at large, as they are now in England and other countries under parliamentary government, or by the members of local assemblies elected in their turn by the people? The writer of this paper is a hearty democrat, and profoundly convinced that the people, with all their passions and defects, will on the whole vote right whenever they see their way. He is persuaded that the great obstacle to voting right, as well as to doing other things that are right, is selfishness, and that this prevails fully as much among the rich as among the poor; indeed, among the rich it is almost erected into a principle, under the pretext of defending the rights of property, as though the rights of the destitute did not require much more to be defended. He is not actuated, therefore, by any conservative prejudice in saying that to him the system of having a central Legislature elected directly by the constituencies at large seems to have decisively failed. There are two points in the process of election, the nomination and the voting. The second point only has engaged the serious attention of statesmen, whose minds have been occupied entirely with problems as to the qualifications for the franchise, the distribution of seats, and the question of the ballot. It is in the first part of the process that direct election has broken down. The people, if left to themselves, will choose rightly between two candidates; but who is to choose the candidates? The people at large can not select from any extensive area; a common man does not see over a hill, much less can he perform the task which Mr. Hare's plan would set him, of picking out the persons of greatest eminence from the whole nation—a process which would infallibly degenerate into a vast party ticket. On the other hand, the worthiest are not very likely to nominate themselves, though the least worthy are. The practical result is that the nominations are everywhere usurped by party organizations and their proprietors, by caucuses and wire-pullers, whose fell ascendency, complete in the United States and Canada, is being very rapidly extended in this country.

The nominations carry with them the elections; the constituency at least has nothing left it but the choice between the two candidates whom the wire-pullers are pleased to set before them, and whose first qualification is of course entire subserviency to party, if not to something narrower still. Nor is there any visible way of breaking out of this fatal circle, which grows continually stronger and more confined. If an independent candidate attempts to offer himself, the wire-pullers on both sides practically combine against him as an interloper and a leader of rebellion against party discipline. The range of their unbeneficent agencies is, moreover, daily extending and affecting every part of public life. It is needless to say that a conclave of Tory squires is just as much a caucus as a Liberal "three hundred." Trusty managers of their own immediate concerns common men will manage to pick out of those with whom they are in daily intercourse, and whose characters they thoroughly know. In Canada persons qualified to judge say that the local elections, where party does not interfere, are good, and best where the area is smallest. An assembly consisting of the chosen men of each locality will be more intelligent than the body of its constituents, and at each remove upward a step in intelligence is gained. The increased importance given to the local assemblies would raise their character by inducing better men to come forward, especially in the cities. Nor, with a limited body of primary electors, is there much practical difficulty about the nominations. A college of electors, called into existence for a single term, such as that which formally chooses the President of the United States, of course becomes a nullity: the result is a mandate: but this would not be the case with a standing assembly, electing periodically members of a central Legislature. The Senate of the United States, elected by the State Legislatures, may safely be said to be in average ability decidedly above any other legislative assembly in the world, and would be an admirable government if party would let it alone; while the House of Representatives, elected directly by the people, is not only inferior to the Senate in every respect, but is a body the meeting of which is by all good citizens justly regarded with dismay, while its departure is welcomed as a deliverance. The primary electors, instead of losing by the change, would gain a real power of indirect election, whereas the apparent power of direct election which at present they possess is an illusion, the reality having been filched from them by the caucus, which is always in the hands of a ring. A wise arrangement of local institutions on the elective principle would of course be the basis of the system, as it is the indispensable training-school of the people in self-government. The elections to the central Legislature, party being out of the way, ought to be by installments, a mode which would allow the steady inflow of public opinion, and at the same time prevent cataclysms such as now attend general elections, which are usually decided by some special agitation or an ex-

citement of feeling on one question, to the neglect of the more general interests of the commonwealth. The term for which each member of the central Legislature was elected would be fixed, and there would be an end of the ministerial prerogative of dissolution, which has run into grave abuse, and may run into graver abuse still, if ministers are allowed to dissolve whenever they think they are sure of winning the elections, and thus to perpetuate their tenure of power. The election of a central Legislature by local Legislatures, and the installments, would no doubt be a tame affair compared with the turmoil of a general election under the present system; and those who think that turmoil is life will at once reject the proposal: to the writer, after observing the politics of a colony and of the United States, as well as those of England, the reverse appears to be the case. Turmoil and healthy political life seem to him totally different things. Mere saving of expense is not a paramount object, but the corruption as well as the enormous waste of general elections would be at an end. Nor is there much danger of stagnation: the world is in a fair way to have agitating questions enough, without breaking heads for Blue and Yellow.

Bad influences—vanity, intrigue, pique, self-interest, corruption, narrowness of view and motive—can not be excluded by any conceivable machinery from any human assembly. But the members of a local council, electing members of the national Legislature, would at least be acting under the eyes of the community, and with something of the responsibility which attaches to the exercise of a personal trust. They would usually have too much largeness of view to vote against an eminent man because he had promoted co-operative stores, or because he had gone wrong on the dog-tax. Nor in any reasonably moral community would they be likely to take direct bribes. It is time, however, as every one who lives under the rule of colonial politicians knows too well, that political corruption, in high places as well as in low, should be distinctly stamped as a crime, and brought under the regular cognizance of justice. It is just as capable of definition and of proof as any other crime, and assuredly it is not the least heinous in the list. For this purpose, as for the trial of contested elections, a tribunal is needed free from partisan influence and open for the reception of charges brought against men in public trusts by any citizen, with proper safeguards, of course, against wantonness or malice. Impeachment is obsolete, and an investigation undertaken by Parliament under the party system becomes a faction-fight. It seems incredible that the framers of constitutions for colonies teeming with corruption should have failed to make any provision for the trial of political offenses.

If we are asked whether it is at all likely that the plan of indirect election will be adopted, the vote for the supreme Legislature having been once ostensibly given to the people at large, we say at once that

at present it is not. The world will have first thoroughly to learn by experience that the existing system is, or tends more and more to become, government by and for the wire-puller, not by or for the people. France is apparently about to make an experiment in the opposite direction, by the adoption at Gambetta's dictation of the *scrutin de liste*. But this is a warning to the rest of the world, the object of the measure evidently being not to improve the elections, but, by canceling all those local influences which on the whole are the healthiest, to render a particular politician more completely master of France.

Representation of minorities seems to have done but little good. The result is a torpid compromise which is likely to continue notwithstanding a change of sentiment in the constituency, because it is the object of all the three members, and especially of the holder of the minority seat, to avoid a contest, so that positive misrepresentation as well as political deadness may be the result. The minority member is nailed to his seat, and can neither take office nor retire, except at a general election. All complicated arrangements are apt to harbor wire-pulling, for the wire-puller, even if he is baffled at first, soon learns the trick. The only measure of this kind which appears to promise real improvement is the adoption of the second ballot when no candidate has polled an absolute majority at the first. This would give opinion, which is apt to split into sections, a fairer chance against a compact interest, and render it possible for an independent candidate to come forward with some prospect of success. At present the wire-pullers invariably succeed in persuading the people that their votes, if given for an independent candidate, will be thrown away.

Experience seems distinctly to have shown that, to make an assembly deliberative, its numbers must be limited. In a Parliament of six hundred or a thousand members, volleys of argument or invective may be exchanged between the two sides of the House, but deliberation is impossible. More than two hundred can hardly take counsel together. There is the resource of grand committees, which, however, is not available with party government, unless the committees are so arranged that the dominant party shall have a majority in each of them. Unless this is done, the full House will be always redebating and reversing the decisions of the grand committee.

With such a mode of election to the central Legislature as has been suggested, it will be safe to combine a widely extended suffrage. It will be safe, and it will be politic. For the instructed and reflecting few, a demonstration of political utility may suffice: proved expediency secures their allegiance; but, to engage the loyalty of the many, it is necessary that government should be administered in the name of an authority to which their hearts as well as their understandings bow. Such an authority in by-gone times was the king; such an authority now is the whole nation. No one who was in the United States at the time of the civil war could fail to see what immense strength that

Government derived from the breadth of the basis on which it rested, and from the universal feeling that it was in the fullest sense the Government of the people. It was enabled in this way to put forth a power which no autocracy could have put forth. Many Americans, it is true, will tell you that universal suffrage is a failure, and that it is the great danger of the state. But they overlook the fact that the danger arises not from universal suffrage by itself, but from universal suffrage in conjunction with party government and direct elections. It is as the tool of faction and its demagogues that the rowdy is politically formidable. Universal suffrage, however, in America, is no doubt to-day a very different thing from what it was when the great majority of the people were substantial farmers, and almost all of them were holders of property, responsible, settled in their habitations, and of English blood. No absolute rule can be framed for all countries, nor even, supposing that such a rule could be laid down, would it be practicable everywhere to get up the hill again, when once you have gone down, and withdraw powers once granted to the multitude. Property qualifications are odious, and, where power is in the hands of the people, to be odious is to be weak. On the other hand, an education qualification is not odious; the writer, at least, has always found that artisan audiences receive the mention of it with favor; it is most reasonable, since a man can hardly give an intelligent vote, or do himself and his concerns anything but mischief, by voting without the common organs of intelligence; nor does there seem to be any insuperable difficulty in the way of ascertaining that an applicant for registration is able to read and write, or at least to read. Writing, perhaps, ought hardly to be required, for the horny hand of the farm-laborer may lose that faculty without default of brain or heart. Under a complete system of popular education, if we ever arrive at it, the school-certificate might be the qualification. All voters ought also to be liable to every civic duty, such as that of national defense, and that of serving on juries, if the system of jury-trial is retained on its present footing. If a sifting process is necessary, let it be one of self-disfranchisement by refusal of equitable conditions, rather than one of disfranchisement by exclusive legislation; the popular feeling that government rests on the broad basis of equality and justice will be less impaired. The sentiment of monarchies and aristocracies has been studied; it is now time to study the sentiment of republics. A good deal of sifting, and, on the whole, of the right kind, would probably be done by abstention, when there were no longer organized factions to marshal the irresponsible, and march them to the poll. As the possession of a vote excites interest in public affairs, the suffrage has a certain educating power, though by no means so great a power as some sanguine advocates of extension have maintained. A consideration, perhaps, of not less importance is that, under a thoroughly popular system of suffrage, the holders of property and the highly educated are spurred by regard for

their own safety, if not by any more generous motive, to "educate their masters." If they knew their own moral interest, they would prefer this necessity for exertion to the torpid security afforded by what is called a strong government to wealth and pleasure. After all there will be risks, great risks, in popular institutions; but, as experience shows, nothing like so great as those which attend arbitrary power. At all events, feeble barriers merely chafe the popular flood; the only chance of safety lies in frankly embracing the democratic principle and framing securities for the ascendency of public reason over cupidity and passion, not in the interest of an upper class, but in that of the whole community.

There is a wide difference between the case of political and that of municipal suffrage. This is a point of the highest importance in America, where the cities are vexed and pillaged by a brood of municipal demagogues, such as the late Mr. William Tweed. Legislatures, in regulating the municipal suffrage, have forgotten the great change which the cities have undergone. In the middle ages they had a political life of their own, and as the antagonists of the rural aristocracy played a distinct part in political development. This belongs to the past; a city is now little more than a densely peopled district requiring a special administration. Moreover, the great merchants who were the leaders and magistrates of the cities in former days do not now live in them, but in villas outside them, nor do they seek city offices; the guilds are dead; the people, even in the same street, know little or nothing of each other. All unity is gone; there is only a human sand-heap, among the grains of which moves with sinister activity the ward politician. The chief, almost the only function of a city government in these days, is to raise and expend money; in equity and reason, therefore, the franchise ought to be in some measure proportioned to the amount of the contribution; it ought to follow the rule of joint-stock companies, rather than that of political communities, in which the poorest man's rights and liberties are of as much value as those of the richest. Nor is the present system in any way favorable to the poor, who are led by the petty bribes offered them by sharpers or rings, and by appeals to their class passions to vote for public plunder. The money goes into the pockets of the Tweeds; and nowhere are the health and comfort of the poorer citizens less cared for than in cities which are under the government of these rogues. A strong, permanent, pure, and enlightened administration, of a thoroughly business and scientific character, is what is needed by the people of every city, and by the inhabitants of the poorest quarters most of all.

Of the question of female suffrage the writer has spoken elsewhere.* The spheres of the two sexes, as he believes, are, like their

* In an article in "Macmillan's Magazine," which at the request of some members of the House of Commons was reprinted, and was circulated by them among the members of the House.

natures and gifts, coequal but distinct, and incapable of identification unless women can take what is now the work of men, and men can take the work of mothers. Law, even in the most civilized states, rests at bottom upon the force of the community, and the force of the community is male. Enactments made by those who had not power to execute them would be futile. Would the men allow the women to vote them into a war, say in defense of a romantic Queen of Naples, or some other darling of female fancy? Would they execute upon themselves the severe laws which women are threatening to make against them in matters connected with the relations of the sexes? If they would, the tyranny of man must be a fable. But if decrees were not carried into effect, and laws were not executed, the government would fall. In domestic life, though a character at least as high as the political is formed, political character is not formed. What would be the condition of a nation in a dangerous crisis like that of secession in the United States, or even the Irish crisis here, if its policy were swayed to and fro by the emotions of the women? The advocates of women's suffrage hardly realize the fact that they are turning government over into female hands; yet in the United States, where the franchise is personal, the female voters would at once outnumber the male; and in England it is well understood that the limitation to widows and spinsters is merely put forward as a mask. The next step would be a demand of eligibility to Parliament and to political office, which is probably the personal aim of some of the female leaders (one of whom, indeed, wanted to be a candidate for the presidency), and could not consistently be refused. But could women in office ever be made accountable like men? A sex which is not thoroughly justiciable can not be made thoroughly responsible; and, when women have interfered in politics, their want of a restraining sense of accountability has appeared. Henrietta Maria, by the indulgence of her feelings, hurried her husband and the country into a civil war, as Margaret of Anjou had done before her; Marie Antoinette, by a similar outbreak of passion, precipitated the French Revolution; and the Empress Eugénie, with fatal truth, called the German War her own. That women can not take part in the defense of the country is an argument which may have been pressed too far; yet they are hereby rendered untrustworthy counselors in questions of peace and war. Some who know the Southern States well say that if the women could have had their way there would very likely have been a renewal of the civil war. The whole history of female government leads to conclusions adverse to the change; the reign of Elizabeth herself, now that we know what she really was and did, as decisively as the rest.

Neither men nor women can plead natural right against the good of the community; the community is the ordinance of nature. Men were not invested by nature with political liberty; they won it by

efforts in which multitudes of them have perished, and they have shared with their families all its substantial advantages. As they have fought, so they have legislated, for their wives and children as well as for themselves. For their wives and children as well as for themselves they have reclaimed the earth, made it fruitful, and bridged the sea. What Mr. Mill calls slavery has, in the main, been the guardianship of affection, a guardianship with which the women could not have dispensed, though the conception evidently never entered Mr. Mill's mind. If the man has had authority over the woman, the woman has had authority over her child. The indissolubility of marriage, which Mr. Mill calls slavery, and which is his capital grievance, is at least as much a restraint upon the roving passions of the man as upon the affections of the woman; in truth, the very fact that man has instituted monogamy and made marriage indissoluble is the most conclusive answer to Mr. Mill's charge. So far from women not being able to get justice in a court under the existing law, the difficulty is to get justice against a woman, and both in America and in England male legislatures have been passing laws respecting the property relations of married people, which in effect release the wife from all the obligations and liabilities of matrimony, leaving the husband as fast bound as ever. American ladies who demand that marriage shall not be a union, but only "a copartnership," would soon flinch from the consequences of their own principle. That domestic outrage exists in barbarous classes is too true; and it is committed as often perhaps by women against children as by men against women, though the complaints of the children are not so often heard; but fifty votes given to the unhappy victims would not correct the brutality of a savage home. The women who head this movement do not really want equality; they want and expect to retain, with political power and freedom from marital control, all the present privileges of their sex. They do not want to be thrust to the wall by male strength in a struggle for existence, to have the penal law extended to them in all its severity, or to be compelled to do the rough and dangerous work of the world. But they will find that they can not have both equality and privilege, or at once renounce and retain the guardianship of affection. Chivalry may linger, as sentiments do linger, for a season; but it will soon fall into the grave of the conditions on which it depends. Perhaps the sex generally will find that they have paid dear for the fancy of the few who wish to enter into public life.

What would be the effect of public life on female character, and the effect of female intervention on the character of public life, are questions upon which some light has been thrown by our actual experience since the commencement of this agitation. About the most violent and scurrilous production which has appeared in the American press for many a day was a series of letters written by a female politician; and it is remarkable that her object was to defend the system of favor-

itism and jobbery in the exercise of patronage against administrative reform.*

The most important point remaining is the ballot, which has now been pretty well tried. The notion that it would specially favor Liberalism is at an end. It annuls all pressure, that of the trades-union or the social circle, as well as that of the landlord or the customer. On the other hand, it affords a cover for individual follies and for all the motives which shun the light. It has failed to baffle the wire-puller for the reason already mentioned; he always succeeds in convincing the mass of electors that a vote given for any but a regular party candidate will be lost. Probably the balance of advantage is on the side of allowing a man to give free expression to his real sentiments, whatever they may be; the result is then trustworthy, and the general action of the voters as citizens will be in accordance with their votes.

That the British Constitution is unwritten, and therefore elastic, may be the boast of Britons, but, like many things which are the boast of Britons, it forms no precedent for other nations. For reasons before given, unwritten traditions or understandings are valid only in these islands. In new-born democracies nothing will prevent the militant politician from using for his own behoof and for the discomfiture of his opponent all the powers which the letter of the law puts into his hands, the sacred principles of the constitution notwithstanding; and thus we find a lieutenant-governor of a province turning out the ministry of the majority in order to transfer the provincial patronage to the hands of his own party on the eve of a general election, and the Senate of the same province withholding the supplies as an ordinary

* The suffrage movement is, in the United States at all events, only part of a movement against the limitations of sex, against the bondage of matrimony and the burdens of maternity. Those who are thus striving to break up the political unity of the family are assailing its integrity in other ways by separating as much as possible the interest of the wife from that of the husband, and teaching her to regard him not with confidence but with jealousy. The writer has heard in several quarters that some of the female leaders of the movement do all in their power to deter young women from marriage. The name of John Stuart Mill, on the banners of the movement, indicates its real character, and shows that it extends to the general status of women. If it spreads in America, the consequence will be, that the Anglo-American race will be supplanted by the Irish and Germans, whose women are loyal to sex, true to the family, and good mothers, while all the Irish and half the Germans belong to a Church by which the family has always been upheld.

What nobody will deny is that the question is one of the most tremendous significance. The family is more important than the state to human character and happiness; and while the state may be regenerated by the family, the family can not be regenerated by the state. Levity, therefore, and concession to vague sentiment are criminal. Man, as the responsible holder of political power, is bound to decide unselfishly and generously; but he is bound to decide carefully and wisely, in the interest of his partner as well as in his own. In England Conservatism has of late been led into strange ways. If, instead of allying itself with beer and ignorance against intelligence, or stirring up war passions as revolutionary as they are wicked and destructive, it would take to guarding property and the family, its just influence in the state would be increased.

stroke of party warfare, when it wanted to upset a government which had a majority in the other House. A young commonwealth requires a written constitution, and a strict one. Moreover, the document, which becomes a political bible, is an instrument of no small power in educating the citizen, and has a conservative influence of the best sort over his mind.

The only point of first-rate importance which remains is the amendment of the Constitution. This ought to be distinctly vested in the nation at large, the sovereignty of which ought to be unequivocally proclaimed; and a mode should be provided by which the sovereign can exercise the power. An elective assembly will not terminate its own existence, or even pass a measure of reform affecting the position of a large portion of its members, if it can help doing so, any more than a king will abdicate of his own accord. The more vicious it is, the less amenable to opinion it will be. The English Parliament in 1832 did not voluntarily reform itself; reform was forced on it by the nation, which threatened it with violence if it held out longer. In 1867 it was let through a trap-door. The more insufferable the American House of Representatives becomes, the more tenaciously will it cling to its evil existence: and electing members pledged to consent to the submission of an amendment for its reformation or abolition would be a desperately difficult process for the people, when the organizations are in the hands of the politicians. The only visible remedy would be revolution: and a revolution, though not a bloody one, would apparently be inevitable if the British nation were to make up its mind to abolish the veto on national legislation at present possessed by the six hundred privileged families represented in the House of Lords. The object might be attained by providing that it should be lawful at any election of representatives for the electors to inscribe on the same ticket a requisition for the submission of a constitutional amendment, and that the Legislature should be bound to submit the amendment to a *plébiscite*, if a certain proportion of the electorate had supported the requisition. No one who is familiar with the character of democracies, and knows the extent of the *vis inertiæ* which prevails in them, will deem the power likely to be too frequently used.

The writer, let him say once more, is fully aware that much of what has been said will to many seem undeserving of practical consideration. He knows well that party government, a second Chamber, and direct election of the central Legislature by the people at large, are regarded as immutable ordinances of nature. Yet this does not shake his conviction that a single central assembly elected by the members of local assemblies, and itself electing the executive, will after sufficient experience be the form finally assumed by elective governments.—*Nineteenth Century.*

SOUND AND RADIANT HEAT.*

By Professor JOHN TYNDALL.

THE Bakerian lecture of 1881 before the Royal Society opens with a brief reference to the researches of Leslie, Rumford, and Melloni. The labors of Tyndall and Magnus, as far as they bear upon the present subject, are then succinctly sketched, their points of difference being signalized and briefly discussed. This preliminary sketch is wound up by a reference to a recently published paper by Lecher and Pernter, who, while supporting the lecturer in the matter of gases, dissent from him in the matter of vapors. These investigators are especially emphatic in affirming the neutrality of aqueous vapor to radiant heat. Following Magnus, they refer Tyndall's results to vapor-hesion, that is to say, to the condensation of the vapors on the surfaces of the plates of rock-salt used to close the experimental tube, and on the interior surface of the tube itself.

In November, 1880, the lecturer's investigations in this field were resumed. Former experiments were repeated and verified with divers sources of heat, and with experimental tubes, some polished within, and others coated inside with lamp-black. The results obtained with the one class of tubes are substantially the same as those obtained with the other.

But even a coating of lamp-black may be supposed to reflect a certain amount of heat, hence the desirability of an arrangement whereby internal reflection should be entirely abolished. This was accomplished in the following manner: A spiral of platinum wire, rendered incandescent by a voltaic current of measured strength, was chosen as source of heat. An experimental tube thirty-eight inches long and six inches in diameter had two circular apertures at its ends, closed by transparent plates of rock-salt, three inches in diameter. The tube was furnished with three cocks—one connected with a Bianchi's large air-pump, another with a purifying apparatus, while through the third vapors and gases could be admitted. Prior to entering the tube, the calorific rays were sent through a very perfect rock-salt lens, by means of which an image of the spiral was formed on the most distant plate of rock-salt. To obtain the image with clearness, the spiral was first rendered highly luminous, and afterward reduced, by the introduction of resistance, to the required temperature. In this way a calorific beam was sent along the axis of the experimental tube without at all impinging upon its interior surface. No reflection came into play; no absorption by hypothetical liquid films, coating the internal surface,

* Abstract of the Bakerian Lecture of 1881, delivered by Dr. Tyndall, F. R. S., on the "Action of Free Molecules on Radiant Heat, and its Conversion thereby into Sound."

could occur ; and yet experiments made with this arrangement entirely confirmed the preceding ones, wherein by far the greater quantity of heat which reached the pile had undergone reflection.

When the source of heat was changed to a carefully worked cylinder of lime, a portion of which was rendered incandescent by an ignited stream of coal-gas and oxygen, the results were confirmatory of those obtained with the spiral. The order of absorption in both cases was the same, the only difference being that the fractional part of the total radiation absorbed in the case of the lime-light was less than that absorbed in the case of the spiral.

To condense the radiation from the lime-light, concave mirrors were sometimes employed, and sometimes rock-salt lenses. The results in both cases were identical.

An experimental tube of the dimensions here given was employed by the lecturer to check his results more than ten years ago. Its interior surface was rough and tarnished, and when warmed dynamically by the entrance of a gas its power as a radiator enabled it to disturb, to some slight extent, the purity of the results. To obviate this, the experimental tube recently employed was provided with an internal silver surface, deposited electrolytically and highly polished. By this arrangement the radiation of the tube itself, as well as its absorption, was rendered quite insensible.

The rock-salt plates used to close the experimental tube, and on which liquid films are also alleged to be deposited, remain to be examined. In this case also an *experimentum crucis* is possible. If the observed absorptions be due to such liquid films, then the separation of the salts more widely from each other, the space between them being copiously supplied with vapor, ought to produce no effect ; but if the absorption, as alleged by the lecturer, be the act of the vapor-molecules, then the deepening of the absorbing stratum ought to produce an augmented effect. For many gases and some vapors this problem was solved as far back as 1863. By means of an apparatus then described, polished plates of rock-salt could be brought into contact with each other, and then gradually separated, until the gaseous stratum between them was some inches in depth. With sulphuric-ether vapor, the distance between the plates being one twentieth of an inch, an absorption of two per cent was observed. With a thinner stratum, or a weaker vapor, even this small absorption vanished ; while in passing from one twentieth of an inch to two inches the absorption rose from two per cent to thirty-five per cent. Such experiments, recently verified, entirely dispose of the hypothesis that liquid films were the cause of the observed absorption.

The vapor-hesion hypothesis involves the assumption that liquids exert on radiant heat an absorbent power which is denied to their vapors. It assumes, in other words, that the seat of absorption is the molecule considered as a whole, and not the constituent atoms of the

molecule. For, were the absorption intra-molecular, the passage from the liquid to the vaporous condition, which leaves the molecules intact, could not abolish the absorption. So far back as 1864 the lecturer had proved that when vapors, in quantities proportional to the densities of their liquids, were examined in the experimental tube, the order of their absorptions was precisely that of the liquids from which they were derived. This result has been recently tested and verified in the most ample manner by means of the apparatus in which internal reflection never comes into play. It furnishes, therefore, the strongest presumptive evidence that the seat of absorption in liquids and in vapors is the same.

As a problem of molecular physics it was, however, in the highest degree desirable to compare together *equal* quantities, instead of proportional quantities, of liquids and vapors. Highly volatile liquids alone lend themselves to this experiment, for only in the case of such liquids can vapors be obtained sufficient, when caused to assume the liquid form, to produce layers of practicable thickness. Two cases, however, have been very fully worked out, the substances employed being the hydride of amyl and sulphuric ether. Careful and exact experiments, many times repeated, lead to the result that when the number of molecules traversed by the calorific rays in the vapor is the same as that traversed in the liquid, the absorptions are identical. In the silvered experimental tube, which, as stated, is 38 inches long, hydride of amyl vapor, at a mercury pressure of 6·6 inches, is equivalent to a liquid layer one millimetre in thickness, while a vapor column of sulphuric ether, of the same length, and 7·2 inches pressure, would also produce a liquid layer one millimetre thick. The experiment has been made with the utmost care, both with the lime-light and the incandescent platinum, with the result that it is impossible to say that there is any difference between the vapor absorption and the liquid absorption. In the face of such facts the vapor-hesion hypothesis, as an explanation of the results published by the lecturer, can not be sustained.

On the 29th of November, 1880, he had the pleasure of witnessing, in the laboratory of the Royal Institution, the experiments of Mr. Graham Bell, wherein a concentrated luminous beam, rendered intermittent by a rotating peforated disk, was caused to impinge upon various solid substances, and to produce musical sounds. Mr. Bell's previous experiments upon selenium naturally led him to conclude that the effect was produced by the luminous rays of the spectrum. The contemplation of these experiments produced in the lecturer the conviction that the results were due to the intermittent absorption of radiant heat. He was experimenting on vapors at this time. Substituting in idea gaseous for solid matter, he clearly pictured the sudden expansion of an absorbent gas or vapor at every stroke of the calorific beam, and its contraction when the beam was intercepted. Pulses far

stronger than those obtainable from solid matter would probably be thus produced, which, when rapid enough, would generate musical sounds. The intensity of the sound would, of course, be determined by the absorptive power of the gas or vapor.

This idea was tested on the spot. Placing sulphuric ether in a test-tube, and connecting the tube with the ear, the intermittent beam was caused to fall upon the vapor above the liquid. A feeble musical sound was distinctly heard. Formic ether was tried in the same way, and with the same result. Bisulphide of carbon was then tried, but the vapor of this liquid proved incompetent to generate a musical sound. These results, which were in perfect accordance with those previously enunciated by the lecturer, were first made public during a discussion at the Society of Telegraph Engineers on the 8th of December, 1880. *

It was obvious, however, that the arrangement of Mr. Bell—a truly beautiful one—was not suited to bring out the maximum effect. He had employed a series of lenses to concentrate his beam, and these, however pure, would, in the case of transparent gases, absorb a large portion of the rays most influential in producing the sound. The lecturer, therefore, resorted to lenses of rock-salt and to concave mirrors silvered in front. He employed various sources of heat, including that of the electric lamp. The lime-light he found very convenient. With the lime-light and concave mirror, sounds of surprising intensity were produced by all the highly absorbent gases and vapors. Among gases chloride of methyl was loudest. Conveyed directly to the ear by a tube of India-rubber, the sound of this gas seemed as loud as the peal of an organ. Abandoning the ear-tube, and choosing a suitable recipient for the gas, the sounds were heard at a distance of twenty feet from their origin. As regards intensity, the order of the sounds in gases corresponds exactly with the order of their absorptions of radiant heat.

Among vapors sulphuric ether stands highest, this result being in part due to the great volatility of the liquid. But the intensity of the sound is by no means wholly dependent on volatility. The specific action of the molecules on radiant heat is as clearly shown in these experiments as in those previously conducted with the experimental tube and thermopile. Upward of eighty vapors have been tested in regard to their sound-producing power.

With regard to aqueous vapor, whose action upon radiant heat even the latest publications on this subject describe as *nil*, it was especially interesting to be able to question the vapor itself as to its absorbent power, and to receive from it an answer which did not admit of doubt. A number of bulbs about an inch in diameter were placed under the receiver of an air-pump, with a vessel containing sulphuric acid beside them. When thoroughly dry they were exposed to an in-

* See "Journal of Telegraph Engineers."

termittent beam. The well-dried air within the bulbs proved silent, while the slightest admixture of humid air sufficed to endow it with sounding power. Placing a little water in a thin glass bulb, and heating it nearly to its boiling-point, the sounds produced by the developed vapor are exceedingly loud. The bulbs employed in these experiments are usually about a cubic inch in volume. They may, however, be reduced to one fiftieth or even one one-hundredth of a cubic inch. When a minute drop of water is vaporized within such little bulbs, on their exposure to the intermittent beam loud musical sounds are produced.

It is to be borne in mind that the heat employed in these experiments, coming as it did from a highly luminous source, was absorbed in a far smaller degree than would be the heat from bodies under the temperature of incandescence.

To render the correlation of sound-producing power and athermancy complete, all the gases and vapors which had been exposed to the intermittent beam were examined as to the augmentation of their elastic force through the absorption of radiant heat. A glass cylinder, four inches long and three inches in diameter, had its ends closed with transparent plates of rock-salt. Connected with this cylinder was a narrow U-tube, containing a colored liquid which stood at the same level in the two arms of the U. The cylinder could be exhausted at pleasure or filled with a gas or vapor. When filled, the sudden removal of a double silvered screen permitted the beam from the lime-light to pass through it, the augmentation of elastic force being immediately declared by the depression of the liquid in one of the arms of the U-tube and its elevation in the other. The difference of level in the two arms gave, in terms of water-pressure, a measure of the heat absorbed. With the stronger vapors it would be easy with this instrument to produce an augmentation of elastic force corresponding to a water-pressure of a thousand millimetres. As might be expected, the intensity of the sounds corresponded with the energy of the absorption, varying from "exceedingly strong," "very strong," "strong," "moderate," "weak," to "inaudible." In this connection reference was made to the interesting experiments of Professor Röntgen, an independent and successful worker in this field.

In conclusion, the lecture draws attention to the bearing of its results upon the phenomena of meteorology. The views of Magnus, regarding the part played by mist or haze, are referred to, and attention is directed to various observations by Wells, which are in opposition to these views. The observations of Wilson, Six, Leslie, Denham, Hooker, Livingstone, Mitchell, Strachey, and others are referred to and connected with the action of aqueous vapor upon solar and terrestrial radiation. Many years ago the lecturer sought to imitate the action of aqueous vapor on the solar rays by sending a beam from the electric light through a layer of water, and afterward examining its spectrum.

The curve representing the distribution of heat resembled that obtained from the spectrum of the sun, the invisible calorific radiation being reduced by the water from nearly eight times to about twice the visible. Could we get above the screen of atmospheric vapor, a large amount of the ultra-red rays would assuredly be restored to the solar spectrum. This conclusion has been recently established on the grandest scale by Professor Langley, who, on the 10th of September, wrote to the lecturer from an elevation of twelve thousand feet on Mount Whitney, "where the air is perhaps drier than at any other equal altitude ever used for scientific investigation." An extract from Professor Langley's letter will fitly close this summary: "You may," he says, "be interested in knowing that the result indicates a great difference in the *distribution* of the solar energy here from that to which we are accustomed in regions of ordinary humidity, and that, while the evidence of the effect of water-vapor on the more refrangible rays is feeble, there is, on the other hand, a systematic effect, due to its absence, which shows, by contrast, its power on the red and ultra-red in a striking light. These experiments also indicate an enormous extension of the ultra-red spectrum beyond the point to which they have been followed below, and, being made on a scale different from that of the laboratory—on one, indeed, as grand as Nature can furnish—and by means wholly independent of those usually applied to the research, must, I think, when published, put an end to any doubt as to the accuracy of the statements so long since made by you, as to the absorbent power of this agent over the greater part of the spectrum, and as to its predominant importance in modifying to us the solar energy."

EFFECTS OF LIGHTNING ON ROCKS AND SOIL.*

By STANISLAUS MEUNIER.

THE effects of lightning on the tops of mountains are often very intense. Among them have been cited such works as the transportation of large masses to a considerable distance. They also frequently include the development of high degrees of heat. The clearest possible proof of this fact is afforded by the superficial fusion of rocks, even of such refractory ones as granite and other crystalline stones. Laussure long ago described vitrifications of this kind on the summit of Mont Blanc; Ramond has found them on the Pic-du-Midi, and Humboldt in Mexico; and the characters they exhibit are everywhere uniform.

The vitrifications are generally only a few tenths of a millimetre thick, but they sometimes extend over surfaces of nearly a square

* Translated from "La Nature."

metre, on which the rock appears to be veneered with a kind of gray or yellowish enamel, in which bubbles or swellings several millimetres in diameter may be distinguished. The specimen represented in Fig. 1, which is exhibited in the geological department of the museum at

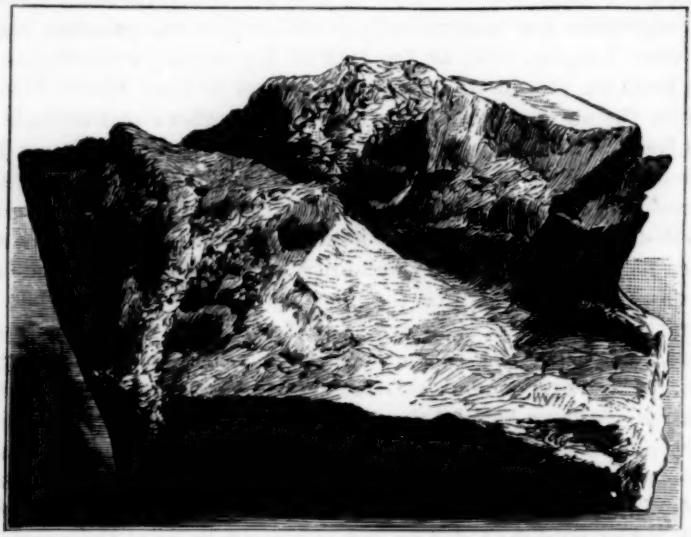

FIG. 1.—BLOCK OF DIORITE FROM THE PIC-DU-MIDI, SHOWING ON ITS SURFACE A MELTED AND VITRIFIED TRACK PRODUCED BY THE PASSAGE OF LIGHTNING. (From a specimen in the Museum; figure one fourth the natural size.)

Paris, was found on the top of the Pic-du-Midi by MM. Baylac and Albert Tissandier. It is of special interest. The rock is of a granitoid diorite, that is, a mixture of triclinic feldspar and hornblende amphibole. The melted portion does not constitute a veneer, as in the examples previously mentioned; it is a track exactly marking the course of the electic spark and ramifying as it did. The vitrified portion extends along the natural external surface of the rock, and then plunges into a fissure, within which it disappears. In this respect the fulguration is extremely like another accident which is known under the name of fulgurites or fulminated tubes, splendid specimens of which may be seen at the museum. As the two cuts in Fig. 2 show, there are irregular tubes, the substance of which, a kind of natural glass, is the product of the solution of siliceous sands that have been struck by lightning. The tube is smooth within, but rugose on the outside, on account of the agglutination of imperfectly melted particles of sand. Fulgurites are generally ramified at their lower end. Their interior diameter varies from a millimetre to five centimetres, or two inches; and their length, which is variable, may reach ten metres, or more than thirty feet.

These curious accidents do not seem to have been remarked before 1711, when Hermann observed them in Silesia; since then all the mu-

seums have secured specimens of them for their collections. It is hard to get large ones, and they command a high price. At first, their true nature was misapprehended. They were regarded successively as incrustations formed around roots that had disappeared; as the cells constructed by worms of extinct species; and as a kind of stalactites. Hentzen seems to have been the first one who attributed them to light-

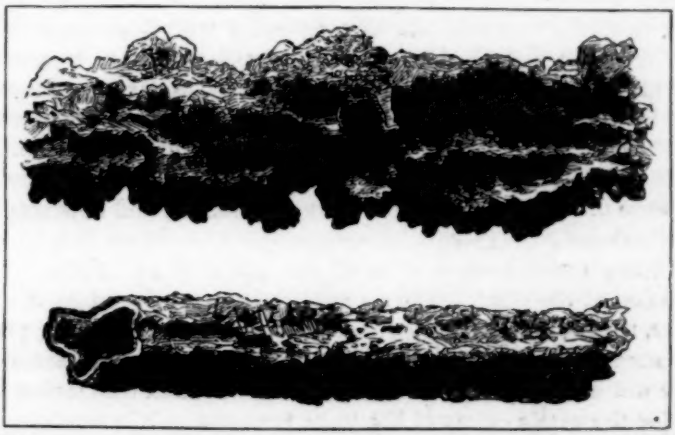

FIG. 2.—FULGURITES. Tubes produced by the vitrification of sand by the passage of lightning through the soil in the deserts of Poland. (From a specimen in the Museum; figure one third the natural size.)

ning; and his opinion has been shown to be correct by Blumenbach and by Tiegler. More recently, Nature has been caught in the act; that is, fulgurites have been found in sand which was still hot, at the spot where the lightning had been seen to strike. Besides, several experimenters, as Beudant, Huchette, and Savart, have obtained tubes analogous to fulgurites by discharging the great electrical battery of the Conservatoire des Arts et Métiers through beds of pounded glass, or of sand mixed with sea-salt to make it more fusible. Fulminated tubes are found principally in places where beds of sand lie upon a soil which contains water, and is consequently a conductor of electricity; for example, at certain points in Silesia, in Eastern Prussia, Poland, Cumberland, and Brazil.

LONGEVITY OF PLANTS.*

BY F. HILDEBRAND.

THE extremes between which the duration of the lives of plants varies are widely removed from each other. On one side, we may see plants that begin and close their lives within a few hours or days; on the other side, plants, the lives of which may be estimated

* Translated from "Das Ausland" for "The Popular Science Monthly."

by the hundred or thousand years. The differences appear conspicuous, not only in the view of the whole vegetable kingdom, but also in single divisions of the same, and whether high or low forms are included. Inasmuch as these conditions are generally known and may be observed by every one who looks into the fields and woods, it may be of some interest to consider more closely the great diversities in the length of the life of plants. Such a consideration will afford a higher interest if we institute in connection with it a comparison of the manner in which the longevity of plants is related to their various systematic affinities; and further, if we include in our survey the question whether the different classes of longevities stand in immediate juxtaposition, or whether there are transitions between them. The results of the latter study will then lead us to the inquiry, by what causes the different periods of life are determined, and how they have been developed.

We begin with a comparison of the life-term and the manner of vegetation of the plant. The shortest periods are found in the cryptogams, among the lower algæ, the growth of which, taking place in an homogeneous and uniform element, water, renders any considerable differentiation of the single organs unnecessary, and thus makes it possible for the whole course of life to be gone through in much less time than can be done in the case of the more complexedly organized air-living plants. In some of the simplest algæ the individual, consisting of a single cell, splits into two new cells which are, or quickly grow to be, like the mother, in form, at least; the life of the mother is ended by the formation of its two children, and these in their turn go on to another division and end their lives in the same manner. So short a period of life, lasting for only a few hours or days, is not known in any phanerogamous (or flowering) plant, not even among those which grow entirely in the water. The more complicated structure even of the simplest phanerogam requires at least several weeks before it can bring its fruit to a sufficient degree of maturity to cast its seed—the essential condition which the plant must fulfill before it can bring its life to a close without endangering the continuance of the species. In the short-lived cryptogams, propagation and the end of life come together. The same is the case with a large part of the phanerogams, while other plants, both cryptogams and phanerogams, do not close their lives with a single propagation of posterity, but repeat their fruit-bearings after definite periods of different lengths. Once-fruiting plants may bear seed either in the first or the second year and then die, or after a series of years, as in the case of the American aloe, while the several-times fruiting ones may bear either in the first or second year, or after several years, and then not die; and a number of degrees of transition occur between all of these life-methods. We turn now to a closer consideration of the causes of the differences.

In the simplest plants, consisting of a single cell, no differentiation

of the parts can be perceived. Food is taken in on all sides alike, and is worked up in the whole plasma of the cell and applied to the growth of the cell-body, to the multiplication of cells by division, or is stored up as reserve food. This is possible because the cell either lives continuously in a uniform element, water, or, if it dries up, simply suspends its life while the dryness continues. The simplest structure, a uniform medium, the most speedy performance of the functions of life, and the shortest life-term, thus go together. Now, take a plant which no longer consists of a single cell, but is a structure of a larger or smaller number of different cells, which no longer lives in a uniform, constant element, but has its body partly in the ground and partly in the air, so that it is exposed to all the changes to which those elements are subject. In this case a complete differentiation of the organs for different life-functions, of which there is no need in the one-celled plant, becomes essential. There must be a root to take up fluid food; leaves to absorb gaseous matters and elaborate them under the influence of light into new substances to be applied to the growth and strengthening of the plant or to be stored up in particular parts as reserve food; and, besides, particular organs, distinct from the food-organs, for propagation, of the most complicated character, such as are not needed in water-plants, where cross-fertilization, so difficult to secure in the free air, is easily and directly effected. Furthermore, since plants rooted in the ground can not move about, the advantage which change of place offers to the extension of the species is compensated for by the seeds and fruits being endowed with peculiar arrangements by means of which they can spread their kind through a wider circle.

Evidently, all these organs can not be formed in a few days, but a considerable time is needed to bring their development and the fruiting process to perfection. Additional complications now enter into the life-relations of the plant. While the fruit-organs perish, when they are separated from the stem at maturity, the life of the plant itself does not necessarily cease when they are dropped, but has a possibility of continuance dependent on a variety of conditions, the chief of which is, whether the other organs have been exhausted or not.

The prolongation of life is also affected by a great number of outer conditions. The plant has to be subjected to the changes of the seasons; it has to struggle for support in competition with other plants; it has to deal with animals, some of which are beneficial, some damaging to it; and it may or may not find a sufficiency of food in the soil in which it is trying to grow. With respect to all its external relations, it must have the faculty of adapting itself, by extending its organs in one or another direction. And this adaptation is complicated by the fact that it has to be modified to meet different conditions, at different stages of development, and that the plant can flourish only when all its stages of growth are simultaneous with favoring outward circumstances, and can be completed while these continue.

These inter-relations of outward conditions and internal adaptiveness bring their advantages and their disadvantages. It is an advantage to annuals that they require only a short part of the year for their full development, and their existence is not endangered by winter frosts or the heats of tropical dry seasons; also that the abundance of seed, which the devotion of their whole life to one effort makes them capable of producing, enables them to spread very rapidly, and occupy all favorable situations in a few generations. It is, on the other hand, a disadvantage that they have to conquer their ground every year, and the tenderness of the structure of their parts above-ground renders them liable to destruction by animals while they have not vigor enough to send forth new shoots. Their continuance is also sometimes endangered by the occurrence of an exceptional season too short for them to mature their fruit.

The least advantageous habit is that of those plants that grow for several years, and produce fruit but once, and it is of the rarest occurrence. Exceedingly well off are tuberous and bulbous plants, whose under-ground perennial organs are protected from the influence of climate and the attacks of animals, have stored in them quantities of reserve food, and are fitted to send out new shoots as soon as favorable weather sets in, and to mature their fruit in a very short season. Hence we find such plants common where the seasons of growth, whether on account of the frigidity or the dryness of the climate, are shortest. They also seem to prevail where the climate is moderately moist and warm; and nearly all water phanerogams are of this class.

It is to the advantage of woody plants that they do not have to build up every year so much of the scaffold on which their flowers and fruits are to grow. If they have evergreen leaves, these contain, at the end of the season, a quantity of reserve food fit for assimilation, and are ready to go to work absorbing more immediately on the opening of a new season. They have also the title of possession in the struggle with other plants, and are protected against animals. They are, however, more exposed to injury from changes of climate than other plants.

Thus, each life-habit has its advantages and its disadvantages; and we may conclude from this that a change from a long-lived to a short-lived form, or the reverse, may take place in consequence of adaptation to changes in outer circumstances. The origin of new habits depends, however, not on external circumstances alone, but upon a certain disposition in the plant, by means of which it is able to adapt itself to new conditions.

The climate has the most important influence upon vegetation, especially upon its endurance and its life-habits; for temperature, moisture, and light are the conditions on which the life of the plant depends in all its stages; and the movements of the air have also their effect upon its existence. When the climatic conditions change, the plant must

accommodate itself to the change, and must thereby, directly or indirectly, suffer a modification in the length and kind of its life. The soil also, and changes in its condition, have their influence, and surrounding plants and animals have their effects, all of which the plant may feel and show very plainly.

Evidence that the causes which we have only briefly touched upon here play a part in determining the duration of the life of different plants is afforded by cultivation and by the geographical distribution of species. It is well known that when plants are taken into cultivation, and exposed to different temperatures, different degrees of moisture, and different soils from those they have been accustomed to, and direct attacks are made upon their growth, they often suffer changes of one kind or another, and the duration of their life especially is affected. Modifications of external influences may be brought about partly by sowing the seed at different seasons from the usual one, partly by artificial stimulation, pruning, manuring, withholding moisture, etc. The object in these processes has generally been to make the plant go through its course faster, so as to secure an earlier blooming or fruiting; and its life has been shortened without that being the real intention. The other object, of prolonging the life, is also desirable; and there are numerous examples in which the life of plants may be lengthened or shortened by different modes of cultivation.

Particularly interesting examples of the evolution of different life-terms are exhibited in the geographical distribution of plants. If we consider the whole earth as to its climate, we shall observe that in a few regions near the equator, that have a uniform climate, plants will grow all the year through without manifesting any periodical preferences. This is the case, for example, east of the Andes in Northern Brazil, in Guiana, and in Java, where the vegetation is green and blooms continuously, where most species become woody, and nearly all live long and bear fruit often; while the short-lived, once-fruiting species retire to the background. In other tropical regions, where a periodical climate is produced by differences in the moisture of the atmosphere, the long-lived plants prevail, and the ground is so occupied with them till the coming on of the dry season that the short-lived kinds can not find room upon it. The case is different in those regions where spots become barren of vegetation in consequence of the parching heat. Then, when the rainy season sets in, the annuals quickly spring up between the bulbous and tuberous herbs that are able to keep their places through the drought. The short-lived species are of most importance where a warm season alternates with a cold one, and the warm season lasts long enough for them to go within its term through the whole cycle of their life, from their seed-time to the ripening of their fruit. As the warm season becomes shorter the number of annuals is reduced, until finally, when the summer is not long enough for any of them to perfect their seed, they

disappear altogether. Thus the persistent, often-fruiting species gain the monopoly on high mountains and in Arctic regions, but with the difference that in some districts they maintain themselves above-ground through the whole year without protection against the climate, while in others they exist through a long period of rest, protected against the injurious effects of the cold by means of their perennial parts under the soil or under the cover of an effective shelter.

Without attempting a closer review of these relations, or of the development of different life-terms in the successive periods of the development of the earth's surface and of the vegetable kingdom, we come to these comprehensive conclusions: A plant has to pass through two phases, one of vegetation, the other of propagation, both of which are conditioned upon the supply of food. In the simplest instances these phases are exhibited in one and the same cell, which, absorbing the food, elaborates it for its own growth, and gathers so much force that two new individuals are produced by division while the mother-plant ceases, by this fact, to be. In another yet similar manner is accomplished the life of those plants which in their complicated structure present an extreme contrast to the simple cell. In this case also the whole feeding of the plant is performed with the sole object of adapting it to the purpose of propagation; but the end is reached in various ways and times, while the attainment of it is not always accompanied with the end of life. Some plants proceed in uninterrupted growth from their origin to the end of the propagation, collect forces on forces, and die exhausted as soon as propagation is accomplished. Others can not reach maturity by a short stage, but require a longer time for gathering their forces. This enforcement is gained either in an uninterrupted course, or, as is more frequently the case, by a series of alternate periods of growth and rest, followed by a period of vigor, when maturity of the fruit is at last reached and the plants die from exhaustion. A third group reach the stage of propagation after a shorter or longer period without giving up their whole strength to the formation of seed, but apply a portion of the nourishment they receive to the formation of perennial organs by the aid of which they continue to grow and become fruitful again, and competent to repeat the same processes an indefinite number of times.

Seeing different plants thus attain very different ages, we naturally inquire what are the causes of the diversity. They depend partly on the adaptation to external conditions induced by climate, soil, and environment, all of which, especially climate, determine the life-habits of plants in various ways, and seem also to affect the length of their life. But these external conditions can not of themselves force the plant to adapt itself to them; it must itself have a fitness to react upon influences acting upon it from without. This is really the case in various degrees, for the variability which a species exhibits by its individuals in different directions extends to the length and the manner of its life,

and attests the faculty it has of suiting itself to those external conditions which are most favorable to its life-habits. We see also how the plants of the earth have undergone improvement in regard to the length of their life under the influence of external conditions and by means of their power of variation, and can conceive how development of this kind can and will go on; for a cessation of the process is not possible.

It is true that not only certain species but whole genera and whole families as well appear now to be firmly fixed as to their life-habits and the longevity of their individuals; such plants, in view of the certain mutability of external conditions must either become migratory, or, if they can not change, must eventually give way to better adapted kinds. Other species, on the contrary, are capable of improvement; their individuals vary among themselves as to the habit and duration of their life, easily adapt themselves to changing conditions, and are able to adopt other life-habits. These changes in life-habit are accompanied step by step by a morphological adaptation of the organs, and thus from species having a definite term of life may be developed new species with other terms of life. The formation of annual species appears especially to be making a progress which began when a periodical took the place of a uniform climate. These species are, on account of the abundance of their rapidly maturing fruit, capable of a rapid improvement, and have had their spread facilitated since the appearance of man, who by his methods of cultivation makes the ground fit for them in places where they otherwise would not thrive.

SODA, A REMEDY FOR BURNS AND SCALDS.

By F. PEPPERCORNE, L. R. C. P.

ACCIDENTAL burns and scalds, even when not very severe, extensive, or dangerous, commonly cause so much pain for an indefinite time, depending probably as to duration and severity a good deal on the age of the sufferer, and on the greater or less degree of sensitiveness of the individual's skin or constitution—not forgetting the feverish reaction, and the dangerous internal secondary inflammations that are apt to follow in some cases—that any easily applied and quickly available remedy and relief, without perhaps the immediate necessity of calling in professional assistance, will be acknowledged as a boon by most persons; and especially so, when it is remembered that the sooner the agonizing burning pain in the part can be allayed, the less chance there is of dangerous secondary effects, besides sloughing, etc., so severely trying to children and old persons.

The usual first applications to these painful injuries, whether so-

called *popular* remedies, or such as are usually recommended by members of the profession, are numerous enough, but can not unfortunately hitherto be considered as generally successful in giving certain and speedy relief from pain, and, too often, intense suffering. One friend will recommend that the parts be covered with flour from the dredger; another will advise fine cotton-wool, or wadding; another, starch in powder, or soap, or treacle, or the so-called Carron-oil, etc.; but hardly one of such applications can be said to give more than very uncertain or temporary relief from pain, although, perhaps, by occupying the attention of the sufferer, they may in this way prove of some *mental* benefit during his sufferings—being indeed employed really for want of anything better—although, in fact, some of these applications, such as treacle, flour, starch, etc., prove so disagreeable in their after-effects, being often difficult to remove and renew, as to add frequently to the poor patient's depression and suffering, owing to their adhering to the injured parts in dry cakes very irritating to the raw surface.

It is now many years ago (see the "London Medical Gazette" of March, 1844) that the author of this paper, while engaged in some investigations as to the qualities and effects of the alkalies in inflammations of the skin, etc., was fortunate enough to discover that a saline lotion, or *saturated* solution of the bicarbonated soda in either plain water or camphorated water, if applied speedily, or as soon as possible, to a burned or scalded part, was most effectual in immediately relieving the acute burning pain; and when the burn was only superficial, or not severe, removing all pain in the course of a very short time; having also the very great advantage of cleanliness, and, if applied at once, of preventing the usual consequences—a painful blistering of the skin, separation of the epidermis, and perhaps more or less of suppuration.

For this purpose, all that is necessary is to cut a piece of lint, or old soft rag, or even thick blotting-paper, of a size sufficient to cover the burned or scalded parts, and to keep it constantly well wetted with the sodaic lotion so as to prevent its drying. By this means, it usually happens that all pain ceases in from a quarter to half an hour, or even in much less time.

When the main part of a limb, such as the hand and fore-arm or the foot and leg, has been burned, it is best, when practicable, to plunge the part at once into a jug, or pail, or other convenient vessel filled with the soda lotion, and keep it there until the pain subsides; or the limb may be swathed or encircled with a surgeon's cotton bandage previously soaked in the *saturated* solution, and kept constantly wetted with it, the relief being usually immediate, provided the solution be saturated and cold.

What is now usually sold as bicarbonate of soda is what I have commonly used and recommended; although this is well known to

vary much in quality according to where it is manufactured—but it will be found to answer the purpose, although probably Howard's is most to be depended on, the common carbonate being too caustic. It is believed that a large proportion of medical practitioners are still unaware of the remarkable qualities of this easily applied remedy, which recommends itself for obvious reasons.—*The Practitioner.*

THE GULF STREAM AND THE PANAMA CANAL.

By JAMES GEIKIE, F. R. S.

NONE of the great "rivers of the ocean" has been so frequently and carefully studied as the Gulf Stream of the North Atlantic. Its course, its depth and breadth, its temperature, etc., have all been laboriously investigated, while its influence on the climate of Northwestern Europe has formed a very fruitful subject of discussion. The origin of the stream is well known. The Caribbean Sea and the Gulf of Mexico are full-charged with the heated waters of the great equatorial current, and it is from this broad and deep reservoir that the famous Gulf Stream issues by the Straits of Florida to flow in a northeasterly direction toward the coasts of Europe. At the narrowest place in the straits the stream measures 30 statute miles in breadth and 1,950 feet in depth, but it gradually widens as it passes north until it spreads out over an enormous area. It has been perfectly well ascertained that the superficial stratum of the ocean throughout the whole vast space between the great Bank of Newfoundland and the coasts of France has a higher temperature than the normal of those latitudes, and is flowing persistently in a northerly and northeasterly direction toward the coasts of Greenland, Iceland, and Spitzbergen. It is doubtful whether all this body of heated water has passed through the Straits of Florida, and some physicists have maintained that only a very insignificant portion indeed has actually streamed out of the Gulf of Mexico. These writers have, therefore, held that a stoppage of the Gulf Stream would have only an infinitesimal effect upon the general temperature of the North Atlantic and the climate of Northwestern Europe. This view, however, has been completely overset by Dr. Croll, whose estimate of the enormous heating power of the Gulf Stream is now very generally accepted. According to this eminent physicist and geologist, the total quantity of heat conveyed by that current is probably equal to that of a stream 50 miles broad and 1,000 feet deep, flowing at the rate of four miles an hour, and having a mean temperature of not less than 65°—a temperature which gradually falls as the current goes north until it is cooled down to at least 40°. This estimate gives us 5,578,680,000,000 cubic feet of water per hour, and

consequently the total quantity of heat transferred from the tropics by this current amounts to 154,959,300,000,000,000,000 foot-pounds per diem. Even if we reduce this estimate one half, the stoppage of the Gulf Stream would still deprive the Atlantic of a quantity of heat equal to one fourth of all that is received directly from the sun by that area.

It is beyond doubt, therefore, that the passage of so great a body of heated water into the North Atlantic, over the surface of which it spreads for so many thousands of square miles, must have a most powerful influence on the climate of those regions to which its heat is brought by prevalent winds. This is the case more especially with France, our own islands, Norway, the Faröes, and Iceland. With us the prevalent winds are westerly and southwesterly, and these, as they sweep across the Atlantic, filch warmth and moisture from the Gulf Stream, which they part with as they pass over us in their course toward the northeast. How very materially our climate is thus affected will be readily seen if we compare the mean winter and summer temperatures of places in the same latitudes of North America and Europe. Thus at Bordeaux, in north latitude 44° 50′, we have a winter temperature of +41° Fahr., and a summer mean of +69·1° Fahr., while at Halifax (Nova Scotia), in the same latitude (north latitude 44·39°), the winter mean is +22·6°, and that of summer +63·5°. Again, at Killybegs (Ireland), in north latitude 54° 38′, the winter temperature is +41·4°, and that of summer +58·7°—the winter and summer means of a corresponding latitude on the Labrador coast being +5° and +49° respectively. Once more, at Wick (north latitude 58° 25′) the winter temperature is +38·5°, and that of summer +56·5°, while at Hebron (Labrador), in north latitude 58° 16′, we get a winter mean of −5·1° and a summer mean of +46·1°. Now, were the Gulf Stream to be stopped, the temperature of the maritime regions of Northwestern Europe would probably fall as low as that of corresponding latitudes in America. In the event of that stream being diverted out of the North Atlantic, the polar currents flowing south would of course occupy the greater portion of the oceanic surface to the west of us, and hence our west and southwest winds would be cold and ungenial. Were such a catastrophe to happen, we may be sure that the Scandinavian Peninsula and a large part of our own islands would not be habitable by civilized man, while Iceland would become as inaccessible as Franz-Josef Land is now. Our own shores would be frost-bound for a large part of the year, and perennial snow and glaciers would appear in our mountain districts. On the other hand, if we could suppose the body of warm water now flowing into the North Atlantic to be largely increased in volume, there can be just as little doubt that the climate of Northwestern Europe would be much improved, and even Spitzbergen and Nova Zembla might be rendered fit abodes for civilized communities.

Strange as it may appear, the records of geology assure us that such changes in the climate of Northwestern Europe have actually happened within a comparatively recent period—certainly within the human epoch. Thus it has been well ascertained that at a time when rude tribes of men, unacquainted with the use of metals, were hunting reindeer in Southern France, a vast area in Northern Europe was buried under a great sheet of ice—a veritable *mer de glace*—like those ice-sheets which cover up such extensive areas in the Arctic and Antarctic regions. Had any one at that time approached the shores of Northwestern Europe, he would have encountered, some fifty miles outside of the present western shores of Ireland and the Hebrides, a vast vertical wall of ice, like that which confronted Sir J. Clark Ross, Commodore Wilkes, and the Challenger expedition, and barred all approach to the Antarctic pole. Could our voyager have surmounted the Scoto-Hibernian ice-wall, he would have discovered that he stood on the verge of an interminable plain of snow and ice, extending eastward as far as the eye could reach. Here and there upon the far horizon he would have observed a few inconsiderable rocky hills, representing the upper portions of our highest mountains—for the ice which then buried our low grounds was not less than three thousand feet thick. Had he advanced inland until he reached those rocky heights he would have found the icy plain sweeping away in all directions, and bounded only by the horizon ; and had he continued his journey toward the east, across what is now the German Ocean, he would have encountered nothing to break the monotonous level until he approached a low line of snow-covered hills and mounds, marking the site of the ice-drowned Scandinavian Peninsula. After attaining these hills, had our imaginary wanderer now shaped his course toward the south, he must next have traversed a distance of more than five hundred miles before he reached the termination of the ice-sheet in Saxony. During this extraordinary condition of things the Arctic-Alpine plants and animals (which are now characteristic of lofty elevations in Central and Northwestern Europe, and of the low grounds of the higher latitudes) occupied the low-lying plains and valleys of middle Europe, a flora like that of Lapland growing in South Germany, Switzerland, etc., and pines and spruce-firs flourishing in Northeastern France, while reindeer, glutton, Arctic fox, lemming, marmot, and others were the prevailing animals of those regions. When we think of the conditions which now obtain in Europe, can we conceive of any stronger contrast than that which is suggested by the few facts which are here summarized? Instead of the splendid navies of war-ships, ocean-liners, and other craft which now crowd its waters, the English Channel had formerly its fleets of ice-floes, and the walrus haunted the coasts of Northern France. When such extreme conditions obtained, it can hardly be doubted that the Gulf Stream, as we know it now, had no existence in the North Atlantic.

Now let us look at another picture of the past, but still within the human epoch. There was a time, then, when the European climate was so genial that many delicate southern species of plants flourished luxuriantly in regions where they can not now exist. Thus, in the neighborhood of Paris, the fig-tree, the Judas-tree, the laurel of the Canary Islands, and other southern species, found a congenial habitat. The Canary laurel does not grow farther north now than Toulon, on the borders of the Mediterranean. It flowers in winter, and repeated frosts would, therefore, prevent it reproducing its kind. That this plant formerly flourished near Paris is thus a striking proof of changed climatic conditions; we can not doubt that at one time the winters in Northern France must have been extremely genial. Moreover, we know, from the character of the plants with which the Canary laurel was associated in that region, that the climate must have been exempt from extremes—the summers were neither so dry nor so hot, and the winters were very much milder. The land and fresh-water shells which were contemporaneous with that remarkable flora in Northwestern Europe tell precisely the same tale, and this is still further illustrated and confirmed by the character of the mammalian fauna. Among the commoner animals at that time occupants of England, France, etc., were hippopotami, elephants, rhinoceroses, lions, tigers, hyenas, etc., and vast numbers of cervine and bovine animals which still occupy the temperate latitudes of Europe. That such genial climatic conditions were due in large measure to a great increase in the volume of warm water flowing into the North Atlantic seems just as certain as that the Arctic climate of the Glacial period was largely induced by a very considerable decrease, or even an entire stoppage, of that heat-bearing current. The presence of many Mediterranean shells in the ancient raised beaches of Scandinavia, the occurrence of mussel-banks in the coast-lands of Spitzbergen, the appearance here and there off the coast of Scotland, the Faröes, and Iceland, of southern species of shell-fish, and the presence of isolated colonies of southern mollusks in the Gulf of St. Lawrence, are all indicative of a former much greater influx of warm water into northern regions than is now the case. Those remarkable colonies of southern species are living evidence of the last epoch of extremely genial conditions experienced in Northwestern Europe—an epoch during which great forest growths overspread wide regions in the north—covering the British Islands, the Inner and Outer Hebrides, the Orkney and Shetland Islands, all Norway up to the extreme north, and most extensive areas which to-day lie submerged in the sea.

Thus, it will be seen how greatly the climate of Northwestern Europe has been, and may yet again be, modified by changes in the flow of the Gulf Stream. Now, if we glance at a map of America, it will be observed that only a narrow neck of land separates the Gulf of Mexico from the waters of the Pacific, and it is conceivable that,

were this isthmus to be submerged, the great body of heated water, that at present finds its way north through the Straits of Florida, might flow directly into the Pacific Ocean. There is no evidence, however, to show that the barrier of Darien has been thus submerged within any recent geological period, and consequently the great changes of climate referred to above could not have been brought about in this way. They were most probably induced, as Dr. Croll has shown, by a remarkable series of physical mutations, which accompanied and were caused by the last great increase in the eccentricity of the earth's orbit. As the next period of high eccentricity will not occur for many thousands of years, we need have no apprehension that we shall be deprived of the genial influence of our friendly Gulf Stream in the immediate future. And when we reflect upon the magnitude of the submergence of Central America which would be required to divert that stream into the Pacific, we may be equally reassured that we are not likely to suffer from its loss in our day, for, before it could be sensibly diminished in volume by this means, the Isthmus of Darien would need to be sunk to a depth of not less than 800 feet, and perhaps even 1,000 feet. We may therefore contemplate with perfect composure the formation of any number of canals across that isthmus. The great work of the famous French engineer will have as much effect upon the Gulf Stream and the climate of Northwestern Europe as the emptying of a teapotful of boiling water into the Arctic Ocean would have in raising the annual temperature in Greenland.—*British Trade Journal.*

RECENT WONDERS OF ELECTRICITY.*

By W. H. PREECE, F.R.S.

I OUGHT to commence, if I carried out the customary practice, by addressing the audience as ladies and gentlemen, but to-night I much prefer commencing with boys and girls, because the two lectures that I am about to deliver to you are really intended to be addressed to the youngest members of the society. I would first direct your attention to the fact that this hall is illuminated by electricity, and, although I do not intend in any way to refer to the electric light to-night, it is my intention, step by step, to lead you up to it, so that, when we part this day week, I hope and trust to be able to let you depart with a thorough and complete knowledge how electricity works and how it produces these marvelous effects. To accomplish this object there are two things most essential: the first is, that I, your lecturer, should be perfectly clear in my definitions, and simple in the

* Lecture delivered before the Society of Arts, December 28, 1881, and reprinted from the journal of the society.

language I use; the second is, that you should devote to me your very earnest and best attention, and strive all you can, by thought afterward, to understand what I mean. I shall use, doubtless, unconsciously, a great many words that are new to you, but which are to me just as familiar as household words. I will, however, try to explain them, and endeavor, if I can, to let those words impart to you the very idea that they conjure up in my mind. At the commencement, there are two words in very common use that many of you have heard over and over again, but which convey, in the way I shall use them, perhaps a different conception. These two words are "work" and "energy." I can readily imagine that one of you boys may say, when I call your attention to the words "work" and "energy," "Why, what nonsense to talk to me about work! Have I not been working as hard as ever I can during the past term to gain a prize, and have not I exercised all the energy I possess to distinguish myself in my class?" But the words "work" and "energy" applied in that sense are applied in a mental sense, and not at all in the physical sense in which I shall use them. Now, I dare say many of you live in town; some may live in the country; but, whether you live in town or country, you all know what a garden is, and what a gardener does. Suppose a gardener, with a ton of gravel in front of him, were told to move that gravel to a height of three feet. He would go to work with his spade; he would move shovelful after shovelful from the ground-line up to the three-feet height, and after he had moved the whole of it you might readily imagine that he would be a little fatigued. Now, whenever a person does anything which causes fatigue, he does what we call work. The gardener, in lifting the gravel, would perform an amount of work which is capable of being measured. I will give you another illustration. Supposing some of you boys were put beside a pile of cricket-balls, and for a wager or prize you were called upon to throw the balls as fast and as far as you could. A good thrower would perhaps throw the first ball eighty yards, he would throw the second ball seventy-five yards, the third seventy yards, the fourth sixty-five yards, and so each ball that he threw would go a less and less distance, until he had no strength left, and he could throw no more balls. Now, that boy would have done work; something would have passed out of him into the balls; he has, as it were, passed something that belonged to him into the cricket-balls, and as a result he feels fatigue through the loss of this something. Take another illustration: Supposing two crews agree to row a race. They start full of life and full of energy; they pull with all their hearts and might, and arrive at the goal, in common language, thoroughly pumped out. Something has gone out of them into the boat. That which has gone out of the crew, and out of the boy who threw the cricket-balls, is what we call energy, and what they have done is to do work upon the boat. Another example is in the case of foot-ball. A boy kicks a foot-ball and makes a splendid goal. To do

that he has sent something out of his body into the ball which hurtles through the air past the goal, and the game is won. In all these illustrations something is done which results in fatigue, work is performed and energy is lost; in fact, work done means energy applied, and energy applied means work done. As mental energy is our capacity for learning lessons, for going through examinations, and that kind of thing, so the energy of the kind I speak of is the capacity for doing absolute physical work. The generality of this energy is immense. It is a difficult thing to grasp the fact that there is something in existence that we can not feel, that we can not touch, and that we can not see, but which gives us all the force and all the power we possess. The earth as it moves around the sun and the earth as it daily rotates upon its own axis are instances of the existence of this energy; in fact, every kind of change produced in the condition of matter, whether it be in its physical state or in its position with reference to fixed objects, means energy gained or energy lost. The energy gained or lost is the quantity of work done on a body, or done by that body; so I want you to grasp, if you possibly can, the fact that every case of motion on this earth—even the sound of my voice, as I now speak to you—is due to the exercise of this particular energy. Lecturing, for instance, is a considerable exercise of energy. A man can lecture pretty well for an hour; he can lecture not quite so well for two hours, but the best lecturer in the world can scarcely keep at it for three hours without losing all his energy, and, like the crew in the boat, being thoroughly pumped out. This energy—or work done, as I have said—is measurable. The gardener who moves his ton of gravel three feet high has done an amount of work that any boy can calculate who will reduce one ton to pounds, and multiply that sum by three. He will then have obtained 6,720 what we call foot-pounds. One pound raised one foot high is the common and ordinary unit of work; 33,000 pounds moved one foot high is called a horse-power, and the horse-power is the mode by which the power of steam-engines is measured. One steam-engine is known from another by its being able to exercise ten, twenty, or fifty horse-power; and so, whether it is merely the lifting of gravel—or a small tube, such as I have here—throwing a cricket-ball, moving a boat, or working a steam-engine, it can all be measured by this simple unit of foot-pounds. Two other terms are necessary in order to make you comprehend what energy is. Energy is found in two conditions—called "potential" from its position, and "kinetic" from its motion. The potential form of energy is that which exists in the form of a wound-up watch-spring: you wind up the spring of your watch, and by doing so you pass something from your body into it—you transfer energy from your own body into the watch, the spring is wound up, and the watch thereby can be kept going for twenty-four hours or more from the storage of energy imparted to it. A clock, again, will go for eight or fourteen days by your wind-

ing up the weight until you impart to the clock energy in this potential form of sufficient power to keep a clock going for a fortnight. In gunpowder there exists a splendid example of the storage of energy. It remains quiescent until heat is applied, when its potential form of energy is at once transformed into its active or kinetic form, impelling a cannon-ball or bullet with tremendous force. Coal, again, is a grand store of energy. All our steam-engines employed in manufactures are set going by the energy that is stored up in coal. This energy has remained stored up in coal for millions of years in the bowels of the earth, it is brought to the surface, and is there used to produce power in the innumerable ways with which you are acquainted. Take food—I had a very good chop just now that supplied me with a store of energy which will enable me, for one hour at least, to talk to you; and, had I not had that chop, I do not think I could have talked to you for more than half an hour, instead of the three quarters more that I hope I may yet be able to get through. I have given instances of energy in its potential form. We will now take one or two instances of it in its kinetic form—that is, when it is in a state of motion. A moving cricket-ball is a good example of kinetic energy. In its passage through the air it possesses kinetic energy, and should the ball catch your head you know pretty well what is the effect. A steamship moving and a running railway-train are kept in motion by the energy imparted to them from coal, and we know what tremendous energy a steamship or a railway-train has, as when a collision occurs there is a terrific smash-up. Our earth is another magnificent store of energy in its rotation every twenty-four hours; a portion of this energy it gives up in the shape of tides. Our tides abstract energy from the earth, which is gradually robbing the earth of its motion, and the result is that our day is getting longer and longer. If any of you live a million years, you will probably find that the day will be a minute longer than it is now!

Such being the two general forms of energy, I want next to give you two or three ideas of the forms in which this mysterious energy appears. I had intended to bring a familiar toy, a humming-top, before you, to show you the energy it contained when spinning: but we have other illustrations of various kinds. Take a piece of a very dangerous material called sodium, a beautiful white metal, of which I have a quantity in a bottle here, put it on a piece of blotting-paper, and then place it on top of the water contained in this glass vase: you will see that the sodium possesses energy in itself in a potential form. The moment it is brought in contact with the water, the oxygen of the water unites with the sodium and produces the effects of heat, light, and sound, the result of the chemical energy of the sodium in its potential form being brought into the active or kinetic form by mere contact with the water. Another instance: Here is the dome of a bell, which I strike with a mallet or hammer, and thereby impart

energy to it, and it sets the whole air of this room in motion, and every tympanum of every ear present is struck by the little bullets of air that are thrown into vibration, and the result is the effect called sound. As another illustration, I will take coal. I take a small piece of coal and warm it in an iron cup, so as to cause it to give out a little kinetic energy in the shape of heat, and, on placing it in this jar of oxygen [experiment performed], you see that the mere insertion of coal, slightly heated, in an atmosphere of oxygen, produces a most brilliant effect, which is the result of the conversion of the potential energy existing in the carbon, or coal, into the kinetic energy seen in the shape of motion, heat, and light. We have even more brilliant effect of this conversion of potential into kinetic energy. Here is a piece of magnesium wire which, when heated [light applied], has its potential energy converted into kinetic energy, and a most brilliant light is the result. But we need not go to light, and we need not go to heat, for instances of energy. I have shown you that energy is a form of motion; that it is so found in sound, heat, and light; but we also have energy as magnetism. There is a little toy-duck floating on the basin of water before me, and I merely hold in front of it a magnet, when you will see that a sort of affection is set up between the duck and the magnet, by the duck following the motion of the magnet round the basin. That is another form of energy. The last form of energy that I wish to draw your special attention to is that due to electricity. You have all seen the vivid flashes of lightning and have heard the dreadful roar of thunder; in those two effects we have energy. It is in its potential form when it exists in a charged cloud, and in its kinetic form when that charged cloud gives its charge up to the earth, and in flying to the earth produces that dreadful effect that we call lightning, with its accompaniment, the roar of thunder. Thus, you have illustrations of energy in its different forms, electrical, magnetical, chemical, heat, light, and motion.

Now comes the question, How is this energy transferred from place to place? You may have all stood upon the sea-beach and have seen the waves dashing upon the rocks, and sent up in the air in white and brilliant spray. You have seen the waves rolling over and over again in glorious breakers upon the sands. You have probably seen wrecks dashed to pieces by the force of waves, all which effects are the result of energy which has been imparted to the water by a storm miles and miles away, the energy of that storm having been transferred by the waves of the water till it meets with the resistance of the shore and produces those effects I have mentioned. Again, energy is transferred by air-vibrations. The explosion of a gun can be heard to a distance of twenty to twenty-five miles; and instances are known where the bombardment of a town has been heard at a distance of one hundred miles. It is well known that the roar of the cannon at Waterloo was heard on the English coasts, at a distance of over one hundred

miles. Again, we have energy transferred from the sun to the earth by that thin, almost immaterial, subtile medium called the ether, by means of which we have motion transferred from the sun to the earth, which gives us at one moment light, at another moment heat, and at a third moment those effects that result in photographs. Energy is also transferred through matter in the shape of heat. I touch the lamps before me and feel them warm because the heat of the incandescent material which they contain has thrown the molecules of the covering glass into vibration, and that vibration imparts a vibration to my hand that gives the sensation of heat; and if I were to put a poker in the fire—which, no doubt, all of you have done—it would be found in a very short time that the heat of the fire had been transferred through the poker to your hand. Electric currents are a form of energy which is driven through matter. Electricity is transferred, principally, through metals; some of them transfer it with great alacrity—for instance, silver and copper. There are, on the other hand, materials, such as dry wood, glass, gutta-percha, India-rubber, and such like, that scarcely will allow any electrical energy whatever to pass through them; and the result is that bodies are divided into two classes, the one called *conductors*, that conduct electricity away, and the other called *insulators*, which prevent electricity from being conducted away. If you have noticed the telegraph-wires passing through the country, you will have seen that they are suspended on little earthenware knobs (there are specimens of the various kinds in use on the table for inspection), which are employed because they resist the passage of the electrical energy through them, and consequently the electrical energy must flow through the wire which they suspend to the distant end, where it is wanted to do work and produce desired effects.

We have now to consider the motive agency. I ought to have said at the first starting, as every boy fresh from school will know, *ex nihilo nihil fit*, from nothing nothing is created, and therefore there can be no effect without its cause There can be no wind without a difference of pressure in the atmosphere to cause motion of the air. At the present moment I can feel a draught, which is due to a higher pressure above and a lower pressure below on the other side of the door, and the air is circulating over my head from the higher to the lower pressure. The chimney-draughts are produced in a similar manner. Why are meteorologists able to tell us that there is a gale coming? Because they know that there is a higher pressure at one spot than there is on another; and where there is a difference of pressure there must be motion of air. So with water at different levels. The tendency is to produce a common level, and the passage of water from the higher to the lower level produces motion and energy. Tides are simply the result of the effort to produce equilibrium in the sea after it has been attracted in different directions by the force of the sun or the moon. Rivers flow because the water high up in the mountains is at a higher

level than the ocean, and the purpose of their flowing is to produce equilibrium, or an equality of level. Heat circulates in our rooms because a higher temperature exists in the fire than in the walls. In the electric lamps before me there is a very high temperature, because the carbon is maintained in a very high state of incandescence, and on the approach of my hand, which is of a lower temperature, toward the lamp, instantly there is a passage of heat from the high to the low temperature, and I feel that heat striking my hand exactly in the same way that I feel the draught (before mentioned) on my shoulders. Lastly, take electricity. We can not speak of the level of electricity; we can not speak of the pressure of electricity, in the same sense that we can speak of the pressure of liquids. We can not speak of the temperature of electricity; but there is a peculiar condition of electricity analogous to all three, analogous to pressure, temperature, and level, and that peculiar quality or condition is called potential. When we speak of electricity of a high potential, it has exactly the same meaning as high level of water, or of high temperature, and wherever two differences of potential are produced, separated by a conductor, electricity flows. Having said so much, perhaps too much, I want to speak to you about the production of electricity. Having shown you the various forms of energy, how it is transferred, and why it is transferred, I want now to say something of the production of electricity. You know very well that a lump of coal is a store of energy; that is evident by placing it in the fire. There are certain contrivances by which electricity can be produced from coal, but the effects are difficult to show to an audience. So we will take zinc, which, for the purpose, is better than coal. Zinc is a grand store of energy in its potential form. Here is a piece which I take up and place in a glass jar, and in that same glass jar I put a piece of carbon. I then place water in the jar, and, if I added to the water a little sulphuric acid, I should produce a galvanic battery; there would be a difference of potential, of which I just spoke, between the zinc and the carbon, which leads to the production of a current of electricity when the zinc and carbon are joined by a conductor. I have forty of these cells, or a battery, down-stairs, and I have two wires connected with its two ends, now in my hands. I know my battery is all right because, you see, when I bring the ends of the wire into contact with each other sparks are produced, which show that electricity is passing. I will not explain those sparks to you to-day, because I wish to talk to you about electro-magnetic effects of electricity and how they are utilized. The first is the production of magnetism. I have here an electro-magnet, which is simply a bar of iron enveloped by an insulated copper wire, and a poker. A poker can be utilized for a great many purposes, but my present purpose is to place it on the large electro-magnet before you. So long as the battery wires are not joined to the wire around the electro-magnet, and, consequently, no current is passing, you see that

I can raise the poker from its position without difficulty; but, now I join on the wires connected with the battery to the coil of the electro-magnet, the poker is attracted with greater force than my strength can overcome. The effect is more perceptible by the use of nails instead of the poker. When the current is on you see that, owing to the attraction of the nails by the magnet, I am able to build up an ornamental triumphal arch of nails, but, directly I take off the current, the magnetism ceases, and the nails succumb to the force of gravity, and fall to the floor. I have here the parts of an electro-magnet disjointed, which I will put together to illustrate the utility of this power of attraction. I place the iron bar surrounded with wire on the table, and, on holding nails to it, you see it possesses no attractive power. If I let the current pass from the battery through the coil, the iron is magnetized, the attractive action is immediately set up, and the nails are attracted. Now, suppose I want to utilize this power to ring this bell—the dome which I struck a short time ago—I place the hammer (which is attached to a piece of iron in position to be attracted similar to the nails, so as to imitate the motion of my wrist) in front of the electro-magnet; I then place the bell-dome on its rod, so that the hammer, when drawn forward, will fall upon it; and, as you will see, the arrangement is complete in that simple form, for each time a current is sent the iron armature is attracted by the magnet bringing with it the hammer which strikes the bell by its forward motion. This is the principle on which all electric bells are constructed. A similar arrangement is employed for giving alarms in case of burglary. A small switch arrangement is attached to the frame-work of the bed-room-door [a small door so fitted was exhibited]; this switch is put on on going to bed, and, should the door be opened by any one during the night, a succession of currents of electricity are sent to a bell, which continues to ring till attended to, and it would be a bold burglar who dared to carry on his nefarious business under such a din. A modification of this arrangement can be adapted to innumerable purposes. In America, where servants are not so plentiful as in England, necessity has compelled the employment of electricity for domestic purposes, to a far greater extent than in England. In nearly every town in America, systems of wires extend to almost every house, in the hall of which is a small instrument [one was exhibited], on the dial of which divisions bear the various words—messenger, carriage, *coupé*, express-wagon, doctor, police, fire, and two or three other things, and on turning the instrument pointer to any division, and drawing down a spring, a call is sent to the central office or bureau, and the instrument there indicates the service required and at what house, and the request is carried out at once. While traveling in America, I was once afraid that I should not have time to reach the nearest telegraph-office, to dispatch a telegram in reference to an appointment; and, on mentioning my concern to the lady in whose

house I happened to be, she put her little instrument to "messenger," sent the current by pulling down the spring, and in two minutes a messenger was at the door waiting to convey my message to the telegraph-office. Time passes terribly quick, and my energy is gradually disappearing, so that I shall have to pass over some of the things I wanted to show you, such as the process of engraving by the electro-magnetic system; how toys were moved, boats made to swim about, and birds to sing. At the recent Paris Exhibition, the varied applications of electricity were simply wonderful and amusing. I have no doubt we shall have a great many of them exhibited, shortly, at the Crystal Palace, where I hope some of you may be able to go before your return to school. I will now show you how this system of producing electro-magnetism can be utilized for telegraphic purposes. On the table are fixed two complete sets of telegraph-instruments, very close to each other, but the set on the right hand belongs to one station, and that on the left hand to another station. You may fancy that the instrument which I touch, on the left, is in London, and that which Mr. Cordeaux touches, on the right, is in Liverpool. For every current of electricity I send from London, I do a little work in Liverpool, and that results in motion, producing sound. The mere depression of my "key" produces electro-magnetism in Liverpool, which attracts a piece of iron and produces a sound. [Illustrated by working the instrument.] The battery attached to my key is in London, and the depression of my key sends on a current which arrives at Liverpool, produces magnetism and sound. By depressing the key rapidly or slowly the sounds may be made correspondingly short or long. [Illustrated.] By an arrangement of dots and dashes, the letters of the alphabet are represented, and experienced clerks can read off the sounds and translate them with astonishing rapidity. To illustrate this to you, I will ask your secretary to write down a short sentence, unknown to my assistants, which shall be sent by one of them, Mr. Cordeaux, on one instrument (supposed to be in Liverpool), and read off by Mr. Cooper on the other instrument (supposed to be in London). [The secretary then handed in a slip of paper to Mr. Preece, and the message it contained was read off by Mr. Cooper, "A merry Christmas to the juveniles."] That is the operation of telegraphy. The sounds are read off as clearly as ordinary spoken language, though mistakes are sometimes made. For instance, a party of young school-girls, out for an excursion once, wished to advise their schoolmistress of their safe arrival at a certain point, and sent the message, "Arrived all right"; but the schoolmistress was horror-stricken to read the message as delivered to her, which read "Arrived all tight." Telegraphically, the difference between the two messages is not great, for the letter *R* is represented by two dots and a dash, while *T* is represented by a dash. Another error in transmission was where a message, "Five fathoms and four feet is ample

for my wants," was delivered "Five fat sows and four feet"; a cricketing message from Lord's, "Jack, bring up two ground-men," was delivered "Jack bring up £2 10s." And, at the time that Commodore Goodenough was appointed to a station in Australia, the message received was, "A commodore has been appointed good enough for the Australian colonies." The system of telegraphy I have just shown is the ordinary one-way method; but it is possible to send two messages in the opposite direction at the same time upon one wire, and this I can make clear, without going into a detailed explanation, by asking Liverpool to send dashes or long sounds to me while I send dots or rapid sounds to him. [This was done.] We go still further, and send four messages in opposite directions, at the same time upon one wire; that is called quadruplex telegraphy. But the acme of telegraphy has been produced in this country by the Wheatstone automatic apparatus. I have a complete set of this apparatus before me. In it the messages are prepared by being punched with little holes (as you now see being done), and I now hold a slip of paper bearing perforations representing the alphabet, which look very much like the patterns used in the Jacquard loom for lace-making. The perforated paper is put in the transmitter, which sends on currents of electricity, representing the holes upon it; these currents of electricity are received by a "receiver," by which they are made to represent dots and dashes recorded on a long slip of green paper, and these dots and dashes indicate to the clerk at the receiving station the message sent. The peculiarity of this instrument is its rapidity, for, by it, instead of being only able to send from thirty to forty words a minute (the limit of the human hand) from 250 to 300 words a minute can be transmitted. At the present moment, there is not a town in this country, where a daily paper is published, that is not in direct communication with London, and receives its intelligence by means of apparatus of this description. Whatever news it is, whether an account of the Canonbury Railway accident, or a panic that may have happened this afternoon in some theatre, or something else now going forward to the country papers, it is being sent by means of this perforated paper and automatic instrument. Those who are interested in the apparatus will be able to examine it closely at the end of the lecture; but it is impossible for me to describe it minutely now, because it would occupy more than one lecture to understand the whole working of the system. It is most extensively employed in this country, where the growth of telegraph business has been enormous. I spoke in somewhat glowing terms of the duties and doings of this automatic apparatus when in Paris, and my Parisian friends rather doubted my statement. However, I induced the French Government to send an officer over to England to examine for themselves the working of this instrument, and to my great pleasure when he came here he found that my statements were under the mark, and only a few days ago,

when an experiment was tried, to satisfy the French gentleman, we were able to transmit, on a wire between London and Glasgow, no less than 352 words a minute. The growth of telegraphy in this country has been enormous. In 1869 there were only 2,000 offices open, there are now 5,500; there were then only 6,000,000 messages sent a twelvemonth, there are now 30,000,000; the income in 1869 was £700,000, it is now £1,600,000; the number of newspapers and clubs supplied with news was then only 173, it is now 803; and there are 326 towns now being supplied with news direct from London. In regard to submarine cables, I have here a box of specimens of the various types of cable laid down, which is well worth examination. Submarine telegraphy has increased during the ten years, from a few hundred miles of cable, to 70,000 miles, which now engirdles the world. There are many other applications of electricity besides telegraphy, such as, for instance, railway-signals. A railway accident recently occurred at Canonbury, where three or four trains were huddled up in a tunnel. I do not know much about the system of signaling used on that railway, but I know a good deal of the system of signaling in use on the London and Southwestern Railway and other lines. The principle of the "block" system is simply that a railway is supposed to be divided into certain sections of a given length, and no two trains are allowed, or ought to be allowed, to be in one section at the same time. If, for instance, the section be a tunnel, such as at Canonbury, and two trains are allowed on it, the risk of collision is great, as recently proved; but, if the block system be thoroughly and efficiently carried out, there ought to be no such accidents. Some twenty years ago, after a good deal of talking, writing, and persuading, I induced the London and Southwestern Railway to adopt the block system. The system in use on the London and Southwestern Railway is my own. A complete set of apparatus is before you, and I will explain its working. A little semaphore is in front of the instrument, which, when down, indicates that all is clear, and, when up, that there is danger, and the train must stop. Suppose the instrument near me is at Waterloo Station, and the other one near Mr. Goldstone is at Vauxhall. That represents a section of the railway, upon which we want to allow one train only at a time. To ascertain if all is clear at Vauxhall, I send a warning signal of two beats given twice, indicating "A train is coming," which is acknowledged by a signal of one beat from Vauxhall; my semaphore arm is down, telling me that the line is clear, and I let the train go on, sending a signal of two beats [this was done] to Vauxhall, to tell him that the train is in. Vauxhall raises the semaphore behind the train to prevent me from sending on another, and I acknowledge his signal, by giving one beat of the bell. The train is now proceeding; the semaphore arm at this end is up, protecting the train, and I can not, I dare not, send another train until I know that the one now going on has arrived at Vauxhall. It is now

supposed to have done so, and he sends three beats upon the bell, which lowers my semaphore arm and tells me "Line clear," and that the apparatus is in working order. On such a system the traffic of a railway can be conducted day by day, and hour by hour, with safety to the public, and with satisfaction and certainty to the railway interest. One other illustration that I must give you, of the application of electricity, especially as my store of energy is not yet exhausted, is the telephone. One of the most beautiful things at the Paris Exhibition was the transmission of music, by means of the telephone, from the Opera-House to the Exhibition Building. At the Opera-House several microphones were fixed upon the stage, and at the Exhibition Building telephones were fixed in rooms into which visitors could go, and, by applying the telephones to their ears, could listen to the overture of the orchestra, or the singing or talking of the performers, as also the hum of the ballet-girls behind the stage. The effect was something startling. I remember one night seeing a Frenchman put the telephones to his ears, and the moment he heard the sounds he threw down the instruments, and rushed out of the room, saying, "*C'est terrible, c'est terrible!*" The Christmas holidays have prevented my having similar arrangements for this lecture, and the best thing I could get ready is a telephone circuit between this hall and a neighboring room. I will call up and ask my assistant to play something on a cornet. [The cornet was heard playing quite distinctly.] That is an instance of what I wished to illustrate to you at the commencement; we have a bugler, full of energy, who blows into his bugle, the energy of which takes the form of sound; the sound-waves, or vibrations, strike the top of the telephone-case, and set a microphone in vibration, which causes currents of electricity to pass along the wire from the instrument at the other end to the one before you. In the receiving instrument the currents sent by the microphone take the form of electro-magnetism, and reproduce the vibration of the microphone upon a disk in front of the electro-magnet, and so we get reproduced in the same form the energy set in motion at the other end, after having passed through various stages. The motion of the cornet is transferred, first, into the motion of the disk, then into the electrical form of energy, then into that of electro-magnetism, then back again into motion, and, finally, to your ears; and you will easily understand from this that electric currents are merely one form of energy. I intend to pursue this subject next time, and show you how electricity is produced in other ways, and how it breaks up chemical compounds into their separate parts; how electro-plating and silvering are done; and, finally, I will show how it produces the beautiful Edison electric light we now have in this room. The elegant chandelier now illuminating this room was made especially for exhibition at this lecture, and was prepared by Messrs. B. Verity and Sons, of King Street, Covent Garden.

QUACKERY WITHIN THE PROFESSION.

THE profession is probably unaware of the progress steadily made by medical quackery in its diverse forms and disguises. Quackery which is not medical—in the sense of being practiced by duly qualified men—is undoubtedly an evil, but its consequences are not comparable with the effects of such quackery as is growing apace within our own ranks, and slowly it may be, but surely, undermining the respect and confidence which the profession has hitherto deserved and received from the public. We sometimes wonder that our calling does not command the warm recognition in certain quarters to which it seems entitled. For a sufficient explanation of this default in the estimation of society, let us look to the prevailing and almost daily increasing popularity of "systems" and "cures" tacitly, if not avowedly, supported or countenanced by the profession. There is a sentimental and mock-heroic spirit abroad which burlesques the candor of "truth-seeking," and even mimics the impulses of chivalry. We hesitate to condemn any system, "lest there should be some good in it," and we are too tender-hearted and polite to deal honestly by its promoters, even though we recognize the fallacy of their pretensions, and more than suspect their motives. This is not a faithful line of conduct in reference to our profession, nor is it loyal to science, which is one of the many constituent parts and aspects of truth. We know, or ought to know, that a perfectly just and truthful conception of the science of medicine must bar the recognition of *systems* and *cures* of any class or description. The art of healing is not a system, and can never be made one. It is simply an intelligent application of the laws of health in the remedy of disease. We study the "symptoms" of a malady with a view to the acquisition of precise knowledge as to its nature, course, and rational treatment. We pursue the investigation of disease over the boundary-line of death, and explore the cadaver with a view to ascertain the effect of the morbid state on the organism and to elicit its organic causes, albeit we too commonly confound effects with causes. We test the powers and analyze the constitution of drugs, and we scrutinize and make careful trial of methods of treatment, to obtain a reasonable acquaintance with their natures and actions. In brief, we take any amount of trouble and resort to every means at our disposal to render the principles and practice of our art *rational*. This is our duty, and it is the only method consistent with self-respect and professional integrity; but, if side by side with this policy, we cherish a spirit of credulity which renders us ever ready to countenance systems of which we can know nothing—because there is nothing to know—and take a false pride in showing friendliness to quacks and charlatans, the good work we our-

selves may do is changed to evil by reason of the actual or implied sanction we give to the bad work done by others. Nothing is so much needed just now as the rise in our midst of a stern and uncompromising apostle of sincerity in science—a man of unpitying animosity to humbug in all its forms, who will not hesitate, at any bidding, to denounce wrong-doing and untruthfulness, let who may be the offender. It is time that a spirit of manliness went out in our ranks to chase away the lying spirit of mock courtesy—the faint-hearted and time-serving sentimentality—which makes us so ready to look kindly on any pretender, and so reluctant to expose any pretense.

There can not possibly be a "system" or "cure" in medicine. There are no rule-of-thumb methods and no *mysteries* in true science. If we do not know what a remedy is, and how it acts, we have no right, as honest men, to employ it. The time has passed for the working of cures by charms and the recourse to nostrums. We pander to the credulity of the unskilled community when we show ourselves credulous. We patronize and encourage quackery when we extend professional recognition to a quack. Every man is a quack—whether qualified or unqualified—who employs a remedy without knowing why, or who adopts a "system" in medicine. The profession must speak out clearly and strongly on this point, and without delay. From the highest places in society to the lowest ranks of the people, there is just now a grievous readiness to "believe in" quacks and quackery. We have ourselves to thank for this most adverse "feeling" and "influence." It is the stirring of the viper we have brought in from the cold, where physicians and surgeons of more robust intelligence than those of to-day left it—the viper we have warmed and fed and brought back to life; and now it is preparing to rise and sting the hand that caressed it. The way to encounter the charlatanry which is making head against science is to be at once more candid and more conspicuously *honest* in our dealings with the public. We must lay aside the last vestige of the robe of mystery, and show by our words and works, our conduct and policy, that medicine is not a science that admits of inspiration, and that the practice of healing is not an art which can be acquired by the unlearned. There is no system or cure, or charm or nostrum, known to the profession; our calling consists solely in the rational study and treatment of disease on common-sense principles. For those who pretend to a sort of inspiration we have no professional friendship; and toward the promoters of systems and 'pathies we can have no leaning, or any feeling other than that of suspicion, if not pity and contempt. They can have no place in our professional intercourse, and we can have nothing to say to them or their work. This is the only sentiment worthy of the medical profession in its dealings with medical quacks, and the time has come when the revival of its old spirit is most earnestly to be desired.—*London Lancet.*

SKETCH OF PROFESSOR B. A. GOULD.

By ERVING WINSLOW.

BENJAMIN APTHORP GOULD was born in Boston, September 27, 1824. He is the son of the late Benjamin Apthorp Gould and Lucretia Dana Goddard. His childhood was marked by many precocious indications of genius, which have been laid up in the memory of a united and gifted family, in which his relations, filial, fraternal, and paternal, have been singularly loyal, honorable, and affectionate. When three years old he read easily and with sufficient expression to make it pleasant for others to hear him. At five he made a fair original version of an ode of Horace. As a lad he was very fond of botany. Starting one day with his brother in pursuit of a flower which grew at a great distance from home, the brother returned to his mother after a long absence, asking what was the matter with his companion. He said they had walked a long time, and that then his brother had fallen and was lying on the ground. He was sought in vain: and when he returned home with his specimen it was found that the persevering boy had overtaxed his strength, fainted from exhaustion, and after his recovery had still followed and accomplished his pursuit. When he was ten years old his family were summoned by written invitations to attend a lecture upon electricity which young Gould had prepared, which proved to be no mere childish play, but a well-considered discourse, illustrated by a complete and neatly constructed electrical machine entirely of his own manufacture. He prepared for college at the Boston Latin School, taking high rank, receiving at one time five prizes, among which was the Franklin, then the only gold medal awarded in the school. He graduated from Harvard University at the age of nineteen, and shortly after was appointed master of the Roxbury Latin School—an appointment made by the committee in view of his scholarship, while in ignorance of the fact that he was under twenty years of age, the regulations of the school forbidding the appointment of any one who had not attained his majority. He retained this position for a year, at the end of which time he resigned, that he might pursue his studies in European universities. These occupied about four years, during which he formed friendships with the most eminent scientists of Europe, which lasted with many of them, such as Argelander, Gauss, and Humboldt, until the close of their lives.

Dr. Gould's study of astronomy was pursued under the learned Gauss and in the scientific courses at Paris, and in the observatory there, then under the direction of Arago. On returning to America he was employed to determine astronomically the various geodetic

stations of the United States Coast Survey. Dr. Gould has proved in his scientific career that he possesses in a rare degree that bold, initiative spirit which is so marked a characteristic of our countrymen. As soon as any progress has been made in any department of science, Dr. Gould has at once turned it to account in his particular domain. Thus, he was among the very first to use electricity for the purpose of determining the differences of longitude, and recording by telegraph the exchange of signals and stellar observations. He had already employed this method, no less exact than rapid, in fifteen series of determinations before its introduction into Europe. Hardly was the transatlantic cable laid, before Dr. Gould started for Valentia, Ireland, and there established the station from which the difference of longitude between Europe and America was determined, and connected the two continents by the most precise observations. The net-work of these determinations thus extended from Greenwich to New Orleans, and covered almost a quarter of the globe. Besides all this geodetic work, Dr. Gould has very largely contributed to the development of pure astronomical science. By his learning, by his publications, by the example he has set in his researches, he has done much to inspire his countrymen with that love of astronomy which is now so widely spread in the United States. Since the commencement of Dr. Gould's career, upward of twenty new observatories have sprung up, which, in the precision of their methods and the closeness of their observations, take full rank with those of Europe. Dr. Gould is not only one of the founders, he is one of the most distinguished masters of the school of American astronomy. He established and supported at his own expense from 1847 to 1861 the first astronomical journal ever published in the United States. Between 1855 and 1858 he organized the Dudley Observatory at Albany, and it was there that the normal clock, protected from atmospheric variations and furnished with barometric compensation, was first used. In his new meridian circle, also, Dr. Gould introduced many improvements of construction, which are to-day in use in all observatories, and it was his clock which gave the time-signals to New York.

From a student and assistant at the Dudley Observatory, a word must be said here of the extraordinary executive power and the personal magnetism which Dr. Gould exercised in his little scientific family. Such a life is always a happy one where a high purpose and unflagging zeal give the key-note, but the kind forethought in every detail of domestic arrangement, the careful insistence on methodical ways in food and sleep at whatever hours they might be sought, in the exigencies of astronomical labor, were invaluable to young men, some of whom were fresh from the safeguards of home. The midnight toils were ever lightened by kind words and encouraging example, the hours at table brightened and instructed, whatever stress was laid on the master by cares within or without; and when the Scientific

Council assembled, and Dr. Gould was surrounded by Bache and Henry and Peirce and the rest, his loyal assistants found their chief still easily first in wit and learning among the brilliant band. Scattered now in the church, the naval service, college, and business, they look back with affection to those days as among the happiest of their lives, and with gratitude to him whose overwhelming anxieties never relaxed his efforts to make them so.

Dr. Gould's "Catalogue of Fundamental Stars" has been used up to a recent date, not only for the calculation of the ephemerides in the "Nautical Almanac," but also as a basis for all observations made in this country.

In view of the special value of ancient observations, Dr. Gould undertook to reduce and to publish all those which had been made at Paris by D'Agelet between 1782 and 1785. He has also reduced all the zone observations made at Washington from 1846 to 1852, in both these cases rendering great service to the cause of science.

The southern heavens being almost unexplored, and offering a vast field for investigation, Dr. Gould, in entire devotion to the interests of science, and setting aside all personal considerations, unhesitatingly responded to a call from the Argentine Republic. Thanks to his personal qualities and his scientific capacity, he soon acquired the complete confidence of the Government, under whose auspices he founded at Cordoba, between 1870 and 1872, an observatory equipped with the most admirable instruments. Here Dr. Gould, being quite independent, and no longer obliged to divide his energies among many different interests, has undertaken a series of great works of remarkable value. He has just published his new "Uranometry of the Southern Heavens," including all stars visible to the naked eye, the magnitude of each star being determined by not less than four independent observations. In the course of these researches he has found as many variable stars visible to the naked eye as have been discovered to this day in the northern heavens. Other labors under these favorable conditions and based on scientific principles have been devoted to the reformation of the boundaries and notations of the constellations. His Uranometry is as final an authority for the southern hemisphere as that of Argelander for the northern. From the results obtained by Argelander and Heis, combined with his own observations, Dr. Gould has deduced a formula according to which the number of stars increases in proportion to the diminution of their luster, and he has suggested that our solar system is not part of the milky way, but of a stellar system to which about four hundred of the brighest fixed stars also belong, and which bisects the milky way at an angle of about 20°.

It is well known that the object of the zone observations made by Bessel and Argelander was to determine the positions of stars from the first to the ninth magnitude, between $-3°$ and $80°$ in the northern

hemisphere. Dr. Gould has just finished at Cordoba a series of like researches, in the course of which he has taken 106,000 observations of southern zones. Almost at the same time he was engaged in a second series of determinations of great precision, involving 110,000 meridian observations between the equator and the south pole. In this work he determines anew all the co-ordinates of the stars observed at different epochs by Lacaille, Piazzi, Brisbane, Rümker, Johnston, Taylor, Maclear, Ellery, and others. He has also made observations of other stars down to the ninth magnitude, which gave him his fundamental positions. By these three great works he has established certain bases for future research. Henceforth the position of all heavenly bodies may be referred to those of well-determined stars, and, by comparing the co-ordinates of his second catalogue with those obtained in the past by Lacaille and others, important conclusions may be arrived at as to the movements of the fixed stars. Dr. Gould has used photographic processes in the determination of star places with great success, and almost all the star-clusters of the southern heavens can be found in the two hundred plates obtained by him, several of these plates containing about two hundred stars each. This latest work is not yet published, but some of the plates obtained the highest prize at the Philadelphia Exposition.

Besides these great astronomical works, Dr. Gould has done much in quite another line, which can merely be mentioned here. The United States Sanitary Commission has published a work by him of 400 quarto pages, containing the results of physiological observations on over 30,000 men from the point of view of statistical anthropology. The same work contains the results of innumerable experiments made in the Federal army upon 1,300,000 men, with a view to determine human growth between the ages of fifteen and fifty.

The climatic conditions of South America were quite unknown in 1872. Dr. Gould has established a net-work of meteorological stations, extending on one side from the tropics to Tierra del Fuego, and on the other from the Andes to the Atlantic. Observations are now made regularly three times a day in twenty-five stations. One volume in quarto has already been published on the climate of Buenos Ayres, and others are being prepared.

On Dr. Gould's first return home for a short visit, a public reception was arranged for him in Boston in response to the following invitation:

> Desirous of testifying to the honor in which your native country and city hold those great services to science, as observer and investigator, which peculiarly propitious circumstances have led you to offer to our sister republic in South America, under the administration of the distinguished President Sarmiento, as director of the Argentine National Observatory and Meteorological Office; and wishing to meet you on your return home with the friendly sympathy of fellow-citizens, and to hear from your own lips something of the results

of your labors, we ask you to meet with us at Wesleyan Hall, on Monday, June 22d, at three o'clock, P. M., for this purpose.

We are your obedient servants,

CHARLES FRANCIS ADAMS,	T. W. PARSONS,
JAMES WALKER,	THEODORE LYMAN,
GEORGE T. BIGELOW,	HENRY A. WHITNEY,
HENRY W. LONGFELLOW,	JAMES M. BARNARD,
RICHARD H. DANA, Jr.,	GEORGE S. HALE,
CHARLES W. ELIOT,	MARTIN BRIMMER,
GEORGE M. LANE,	WILLIAM GRAY,
WOLCOTT GIBBS,	W. G. WELD,
H. L. EUSTIS,	J. H. DIX,
O. W. HOLMES,	ALEXANDER AGASSIZ,
	and others.

The late Hon. Richard H. Dana presided, introducing an eloquent address by Dr. Gould, and in his words of welcome said:

We have met to express our respect to him for his learning and abilities, and the courageous manner in which he has devoted them to this new field of investigation—banished from home, and from every association which his childhood and manhood had made most dear to him. . . . We feel now that there exists a bond between that great republic of the South and our own—that she has shown the same spirit of enterprise that has caused our own advance—and we rejoice that through their honored President, Sarmiento, the man of science was invited from this country, who should open some of those great fields of exploration for which her wide territory and cloudless skies present such facilities. Our sympathy and our admiration should be expressed toward the people of the Argentine Republic, and we trust that Dr. Gould will give them to understand that the citizens of his native State have a strong feeling of respect and gratitude to them for the paths they have opened and the progress they have made.

It is in these regions, so little known, that Dr. Gould has been laboring for four years, a missionary of science, under strange skies, as well as on foreign soil, among a new people; and on his return to his native town we are met to give him a cordial welcome, to express our pride that he has secured this opportunity to the honor of American science, of New England and of Boston.

Dr. Gould is a member of the Royal Astronomical Society of London, of the French Academy of Sciences, of the Academy of St. Petersburg, as well as of the American Academy of Science, and many other learned bodies. He has given to the world works which will be classical, and in the history of his country his name will stand among those of the most illustrious *savants* who have contributed to the development and advancement of science.

Dr. Gould was married October 29, 1861, to Mary Apthorp Quincy, a helpmate without whom his long expatriation would have been a banishment, and without whose sympathy and active assistance his greatest labors would have been impossible.

ENTERTAINING VARIETIES.

THE MOUNTAINS OF THE MOON;

OR,

TRAVELS AND ADVENTURES OF HAKIM BEN SHEYTAN.

TRANSLATED BY F. L. O.

INTRODUCTION.

THE result of the first Tunisian expedition to the interior of Africa is too well known to require here more than a general mention. After the treaty of Khundabad, the commander of the exploring-party tried to reach the Mongha highlands by following the valley of the Bar-el-Nûn, and had already crossed the foot-hills that form the western boundary of the Fant hunting-grounds, when the vanguard of his auxiliaries was routed by an attack of the Galla marauders, who captured sixteen of his companions, including his five Tripolitan merchants, and effected their retreat across the mountains before the arrival of the Khundabad rescuing party. But this very disaster, which defeated the immediate object of the explorers, helped to enlist the aid of the Tripolitan Government, and thus led to the marvelous discoveries of the second expedition.

In the last week of November, 1878, the command of Marut Pasha assembled at Wady el Kamr, where they were joined by a troop of Tunisian volunteers, mostly relatives of the captured merchants. Hakim Ben Sheytan, the medical and *quasi*-scientific *attaché* of the expedition, had been appointed at the special recommendation of the mollah or high-priest of Tripoli, who had also induced the government to furnish the commissary supplies from the Dey's own Beit-el-Habbada or body-guard barracks. The caravan reached Moorzook in midwinter, and, in spite of the doctor's protest, the commander attempted to cross the Bedeyat lowlands before the end of the rainy season. The Harra-Ghul, the terrible jungle-fever of the waddies, broke out before they had reached the Soodan hill-country; the Tunisian volunteers, and at last even the pasha's veterans, were decimated by the epidemic, and upon their arrival at Darfoor all but twenty of them had to be sent to the Arabian hospital. But the instructions were very stringent: the sick were left in charge of a native surgeon, and with twenty-five followers, including Dr. Sheytan and three Darfoor guides, the commander continued his journey to Galla-land. They followed the windings of the Bar-el-Adda, a stream that takes its rise in the Mountains of the Moon, and at last reached the land of the Khundi Fants, and made their way to the chief village, where the news from the frontier

brought them to a full stop. The Khundi chieftain, however, received them hospitably, and, being on trading terms with the Gallas, offered to mediate the ransom of the merchants. Pending these negotiations, the Tripolitan commander had to go into camp, and now and then led a hunting expedition to the western Sierras, while the doctor tried to requite the hospitality of the Fants by nursing the sick of the chieftain's household. His success gradually extended his practice to a rather undesired degree, since the messengers from the highland settlements kept him nearly all day in the saddle; but during one of these trips Dr. Sheytan crossed the main ridge of the Moon Mountains, and in the ultramontane valleys discovered such a remarkable race of autochthones that he considered the Khundi-town delay the luckiest accident of his life.

The Monakees, or inhabitants of the western Moon Mountains, appear to be unlike any other race of the known world. In mechanical arts advanced far beyond their neighbors, they are at the same time addicted to most preposterous habits and superstitions. With the aid of an interpreter, and his knowledge of the Fant-Arabian dialects, the Hakim interviewed their priests and medicine-men, inspected their dwellings, caves, and temples, and visited many of their outlying villages, and continued his investigations even after his official duties had recalled him to Khundabad. For the Khundi chieftain, in the mean while, had ascertained the whereabouts of the captive traders, and finally effected their release, and after the end of the next rainy season the Tripolitans returned to Darfoor, where the Hakim took charge of the sick, and employed his leisure in writing the chronicle of his discovery. This chronicle, addressed to his kinsman, the mollah of Tripoli, gives a circumstantial description of the Monakee race, their habits, physical peculiarities, and singular superstitions—interpersed with an account of his personal adventures and of the reflections which occurred to him while traveling through their country. "The work abounds with incidents and graphic descriptions," says the reviewer of the first German translation, "as well as with scientific disclosures that throw a suggestive light on the origin of the customs and vices of civilized life." Besides his first professional trips across the frontier, the Hakim seems to have spent nearly eight months among the Monakees, collecting information on all possible topics, interviewing the just and watching the wicked, traveling from village to village, often at the risk of his life, but always sustained by the conviction that "Allah had appointed him to perform this work," and the hope that the world would recognize its importance.

The result has fully justified that hope. Even the first rumor of the discovery created a general sensation at Tunis, and was repeatedly discussed during the October sessions of the Vienna Geographical Society, though it was not yet positively known that the explorer had crossed the western frontier of Khun-Fandistan; but the controversies

on this point were soon settled by the famous circular of Dr. Reidor, to whom the Tripolitan Government had intrusted the publication of the Hakim's chronicle. As the preliminary account of the *Anabasis* through the Soodan waddies (sufficiently known from the writings of Barth and Burton) is little more than a collection of military march reports, it has not been included in the second edition of Dr. Reidor's translation, and the present brief summary will suffice for the explanation of subsequent events.

But the chronicle itself is a work of quite a different character, and at once attracted the attention of the scientific public. Its general interest may be inferred from the success of the German * and Spanish † editions, though the speculative portion of the original has been partly omitted in both works, and, strangely enough, especially in the German version, whose (Austrian) expurgators have found it necessary to suppress the most interesting political and ethical reflections. I shall offer no apology for having restored those passages. From European prejudices the author of the "Chronicle" is as free as Hafiz Ben Eddin, but his work is certainly not immoral, and can be called irreligious only where that word has not yet ceased to be a synonym of truth-loving. The commentaries of the Spanish translator have greatly aided me in the exegesis of the Mauritanian idioms; but, where a literal translation would fail to elucidate the ambiguity of certain topographical terms, I have thought it safer to retain the nomenclature of the Arabian text. F. L. O.

THE CHRONICLE OF HAKIM BEN SHEYTAN, THE SERVANT OF ALLAH.

CHAPTER I.

In the Name of the All-merciful, etc., Adna-Mullah Ibn Saddi: To my Father, Greeting and Peace.

Not now, Namullah, nor in weeks of speech and free discourse, could I recount all the hardships of our journey since we parted at El Kamr. And yet I praise the Lord, and through these, and twice as many dangers I would go again, for all the wonders he has thus revealed, and for the ever-memorable manifestations of his judgment upon the impious who violate the laws of his Word, the laws which Nature has proclaimed even to the heathens.

The death of Abu Riyah you will have learned from the pasha's report, as well as the fate of Sheik Hanbal's companions; and I will begin my relation from the Alms-week of the New Year (February

* "Die Wunder des Mond-Gebirges. Von Prof. D. R. Widerleger." 2 vols., sq. 8vo. Vienna, 1881.

† "Las Aventuras de Hakim Ben Sheytan. Por el Dr. S. L. Reidor." 2da edicion. 8vo. Salamanca, 1881.

9th–16th), when the last messenger departed from our camp at Khundabad.

After the recovery of his imam, Sheik Kedar (the Khundi chieftain) treated me with great kindness, and urged me to remove my tent to his cottage-yard; but I had set my heart on visiting the towns of the Monakees, and the plan moved my soul night and day, especially when the Fanti traders gave me to understand that the emir was anxious to see me, and was going to send me a guide and a traveling present. Our commander considered that report as an idle rumor, but on the last day of the Alms-week our doubts were removed by the arrival of a messenger with a grace-firman (safe-conduct) of the Monghistan emir, whose son had been stricken with a sore disease, and who (supposing that I had entered the service of the Fants) besought the sheik to grant me a leave of absence. My departure was then decided upon. The messenger returned to announce the shiek's consent, and, three days after, the pasha intrusted me to our old guide Abbad, surnamed El Karman ("the Maimed," from the loss of three of his fingers), and we ascended the mountains, by way of the North Pass, where a month ago my companions had captured the strange baboon I sent you with the cargo of the Tunisian traders.

But the weather was now much drier, and I urged the Karman to speed our march, for my soul had grown restless with wondering expectation. All reports presaged a land of marvels. The texture of the Monakee garments was said to be superior to the best linen of Soodan, and from the excellence of their weapons the Monakees were dreaded as foes, though not loved as allies. Far stranger than all the rumors about the marvels of their country were the doubts about the *humanity** of their race. The perfection of their manufactures inclined some to credit them with superhuman skill, while others argued that their habits and appearance proved them to be an inferior variety of monkeys. My own opinion I shall give by-and-by. Of their skill in textile fabrics I had a proof when the Karman showed me a pair of foot-sacks (*calcetes*, probably a sort of woven gaiters), gay-colored and of great strength, and cheap withal, though not to the weavers; for my guide told me that such goods are manufactured in houses where the air is thick with dust, and where scores of the young Monakees are killed with overwork.

People who treat their own children so unkindly can not be expected to show much mercy to their enemies, and I did not wonder when we passed a field where human bones were bleaching in large heaps—the monuments of a battle in which the Monakees had slain twenty thousand of their neighbors. Still I thought that the cause of the war

* "Menschlichkeit," W.—*Cristianismo*, says Dr. Reidor, probably from an inadvertent confusion of correlative terms. Even in the language of our country-people the two words are sometimes used as interchangeable synonyms, as in the phrase, "He takes his grog just like a Christian"—in referring to the accomplishments of a trained monkey.

might somehow justify such deeds, but I learned that the sole object of the invaders was the suppression of certain views or doubts about the secrets of a future existence. Their adversaries, it seems, confine their worship to the God of the Sun, while the priests of the Monakees address their prayers to several other deities, especially to the Man in the Moon, whom they call the nephew of Allah. It is true that they also assert the superior sanctity of their nation, and, the Karman's faith being opposed to theirs, I was unwilling to adopt his views on this point; but even before we had entered the dwellings of the Monakees I could not help noticing a peculiar smell in the air, an odor resembling the fumes of the East-Bombay * rum-shops. A few miles farther west we met a poor boy, who took to his heels as soon as he saw us, though the Karman called after him to stop and not to mistake us for Monakees. He belonged to the race of the Musanites, a tribe of dissenters who live here and there in the Monakee settlements, and seem to be treated well enough as soon as they have acquired a certain amount of wealth, though the poor ones are often subjected to gross indignities. Their offense, too, consists only in a difference of opinion. They seem to be a harmless and very industrious sort of people, but they have no great faith in the Moon-man.

We made thirty miles the next day, and toward evening crossed the Monghistan frontier on the west shore of a dry river-bed. I have seen Persia and India, and the palm-gardens of Yemen, but I believe that this country was originally far more favored by Nature: mountains constantly alternate with plains, highlands with terrace-lands, all intersected by lakes and broad river-valleys, and considering the fertility of the soil it seems that Monghistan must once have been a land of transcendent beauty. Once, I say, for the river-beds are now dry; the lakes are bordered with naked rocks. While Shadissa Ibrahim † (may Allah receive his soul kindly!) did his best to redeem our land by planting millions of shade-trees, these unfortunates seem to vie in destroying the last remnants of their woodlands; on all the ridges I saw heaps of felled trees, and in the plains moldering stumps are the only traces of the original forests.

Here, as in India and Darfoor, I have noticed a strange circumstance. As soon as the tall trees (*Hochwald*, W.) disappear, the underbrush becomes thorny; acacias, mimosas, prickly palms, cactus, and camel-thorns are here the only wild-growing shrubs. By this armor of spines Allah seems to protect these poor plants against the hand of the destroyer, though the Turks of Stamboul would probably say that the thorn-trees were there before the destruction began, and were able to hold their ground while other trees perished.‡

* "Bumbad el Shork," East-Bombay, a suburb of sailors and gamblers.

† Ibrahim Pasha.—Mehemet Ali and his son Ibrahim planted 20,000,000 forest-trees in the Thebaïs and along the shore of the Red Sea.—(Marsh, "Man and Nature," p. 189.)

‡ Dr. Reidor understands this passage as an allusion to the Darwinian survival theory,

The highlands, however, are still pretty well wooded, and there is no lack of game, though the extraordinary shyness of the birds shows that they must suffer much persecution. Of the four-footed animals, too, the smaller ones are more timid and the large ones much fiercer than in our own country; at our approach deer and rabbits fled with incredible swiftness, and, when we went into camp, a troop of baboons up in the rocks kept up a continuous sort of coughing bark, like enraged watch-dogs. The Karman told me that the Monakees kill them without mercy, and I must own that they are certainly very provoking brutes. Yet they are children of our elder mother* and have preserved the knowledge that men have lost by their sins. "They know the way, and teach us without speech," as the poet says; and for days have I often watched them without sating my pleasure. Their inquisitiveness tempted them to approach our camp from behind, and, if we pretended to be otherwise engaged, they came nearer and nearer and diverted me much as I watched them from behind my shawl-tent; but, if my rogue of a guide rose suddenly to his feet, they fled with shrieks that made our ears ache. At last I persuaded the Karman to keep quiet, and just before sunset another troop came down from the cliffs on our right, and tried to steal upon us by crawling along under cover of the bushes and rocks. They walked on all-fours, but now and then one of the old ones would raise himself on his hind-legs to reconnoiter, while the youngsters raced around like frisky puppies. I verily believe that they would have entered our tent if we had continued to keep still; but, seeing that one of the youngsters had approached within a dozen yards of the camp, I made a sudden rush, just as he was in the act of climbing a tree-stump. Before he had reached the cliffs I overtook him, and finding escape impossible he threw himself on his back; and, instead of fighting me when I tried to lay hold of him, he leaped upon my arm, and, hugging it with all his might, began to chatter, very much like a prisoner pleading for mercy. But, when I grabbed him by the neck, his chattering turned into piercing shrieks, that continued even after I had wrapped him up in my shawl. His relatives had rushed up the cliffs like a flock of frightened goats; at the sound of the screams, however, they suddenly stopped, and some of the old males began to move upon our camp with hoarse yells that often resembled the challenge of a human voice.

They had advanced within half a stone's-throw, when the Karman whispered to me that in Kapibad† I could buy young monkeys by the dozen, and that we had better let this one go. As the noise was grow-

but Professor Widerleger is probably right—that it refers merely to the ridicule which the metropolitan Turks are apt to visit upon the theological speculations of the Arabs.

* "Beni abd'il Kabira," *hijos de la prima madre;* a term derived from the writings of the Sufist mystics.

† The chief town of Monakistan.

ing deafening, I concluded to follow his advice; so, taking the youngster out, I put him on the ground and gave him a slap as a hint to be off. At first he did not stir, though he kept up his screams; but, seeing me retire behind the tent, he ran for his life and soon rejoined his relatives.

As soon as the old ones caught sight of him they stopped their yelling, and, crowding around him, seemed to examine him very carefully, after which the whole troop wheeled around and rushed away much quicker than before, as if they had not overcome their natural fear, and risked their lives merely to save the youngster's—which shows that these animals treat their young ones more kindly than the Monakees (with all their gods) treat their children.

The next morning we started at sunrise and ascended the slope of a mountain whose rocks were covered with creepers,* bearing clusters of sweetish berries. To the production of these berries, and a broad-leafed weed (both used for the purpose of intoxication), the Monakees devote a considerable portion of their arable territory, which seemed the more surprising as I was informed that thousands of their poor live in bitter want of their daily bread. Yet the luxuriance of those noxious weeds proves their planters to be expert husbandmen, and they can certainly not be reproached with laziness, whatever may be their other vices.

After a march of three or four hours we reached the southern slope of a harrat,† and I beheld now for the first time one of those famous rock-kraals of Monghistan, a sort of city, crowning the brow of a distant hill. The houses looked like white dots on the blue heights, but even at this distance I could distinguish a peculiar kind of conical castles that towered high above all other buildings. These piles, the Karman told me, were temples of the Moon-man—mosques, so to say—some of them so elaborately finished that they had cost wagon-loads of money, and the labor of countless masons. Their very dimensions attested the skill of the architects; but I marveled that people who could do so much for the moon had done so little for their earth; the valley at the foot of the harrat was in a wretched condition, a sheer quagmire, studded with lagoons and reed patches, though a little drainage would have turned those bogs into fertile fields.

Still, Allah has not withdrawn his hand from this country, and at the bank of a little creek farther below I saw bottom-lands that would support more trees to the acre than our poor waddies on a square mile. And even the driest valleys abound with water-signs; if these poor people had learned the *sheriat-wakil*,‡ every field of their country would be blessed with good wells.

* "Schling-Pflanzen," twining plants or vines.

† *Harrat*, from *harr*, heat or fire. A mountain of igneous rocks, a basalt-hill.

‡ Sheriat-wakil, the "water-place science." Pallas says that the Arabian well-finders eschew the tricks of the divining-rod mystics, and follow a system of practical rules that

Before we reached the top of the next ridge the heat of the day obliged us to halt in the shade of a rock-tomb; but curiosity soon got the better of my fatigue, and after a short rest we continued our march toward a river-valley, where we expected to meet the first living Monakees.

—— *Curious Matrimonial Anomaly.*—Hassanyeh Arab wives enjoy at times "a freedom from the ties and responsibilities of the marriage state unknown, I believe, to any other race in the world." When the parents of the man and woman meet to settle the price of the woman, the price depends on "how many days in the week the marriage tie is to be strictly observed." The woman's mother first of all proposes that, taking "everything into consideration, with a due regard to the feelings of the family, she could not think of binding her daughter to a due observance of that chastity which matrimony is expected to command for more than two days in the week." After a great deal of apparently angry discussion, and the promise on the part of the relatives of the man to pay more, it is arranged that "the marriage shall hold good, as is customary among the first families of the tribe, for four days in the week—viz., Monday, Tuesday, Wednesday, and Thursday; and, in compliance with old-established custom, the marriage rites during the three remaining days shall not be insisted on, during which days the bride shall be perfectly free to act as she may think proper, either by adhering to her husband and home, or by enjoying her freedom and independence from all observation of matrimonial obligation." —*Spencer's "Descriptive Sociology."*

—— *A Healthy Climate.*—Papua is the paradise of birds, Natal of large quadrupeds, Surinam of snakes, Java of butterflies, but Borneo of crocodiles. On a river-island, hardly a mile in length, Professor Keppel counted not less than 740 of these eupeptic pets. But the climate in which, as reported several years ago, things have got most mixed, is New Holland, where it is summer when it is winter in Europe, and *vice versa;* where the barometer rises before bad weather, and falls before good; where the north is the hot wind and the south the cold; where the humblest house is fitted up with cedar and mahogany, and myrtle is burned for fuel; where the swans are black, and the eagles white; where the kangaroo, an animal between a squirrel and a deer, has five claws on its fore-paws, and three talons on its hind-legs, and yet hops on its tail; where the mole lays eggs and has a duck's bill; where there is a bird with a broom in its mouth instead of a tongue; where there is a fish one half belonging to the genus *Raia* and the other half to that of *Squalus;* where the pears are made of wood with the stalk at the broader end; and where the cherry grows with the cherry-stone outside.

apply to every kind of soil or rock. They have an endless list of "signs"—"indications," as our gold-hunters would call them. Every tribe has its professional sheriat-nebbed; and where a committee of these experts fail to find water there is a strong presumption that Allah must have withdrawn his hand, as from the deserts of Western Hadramaut, where on an area of nine thousand square miles an artesian explorer might bore through to the antipodes without attaining his object.

EDITOR'S TABLE.

SCIENCE AND PARTY GOVERNMENT.

IT would be hard to name two subjects which, in the general apprehension, are further removed from each other than those associated in this title. That science may in some way have possible relations with government and politics is vaguely believed by many, because they often hear the expressions "science of government," "political science," etc. But, as nothing is ever heard of any such thing as "party science," political partisans naturally conclude that, whoever else may be disturbed by this intrusive influence, they, at all events, may give themselves no trouble about having to reckon with it. But they repose in a false security As civilization goes on and the laws of its progress are better understood, it will be found that science has more and more to do with government, and, therefore, with the methods and practices by which government is administered.

This matter is dealt with incidentally in the able article of Professor Goldwin Smith, on "The Machinery of Elective Government," herewith reprinted, and which will repay attentive perusal. The writer has familiarized himself with the workings of the elective system, in various conditions and in its most advanced forms, as illustrated in England, Canada, and the United States, and he discusses it with the discrimination of a critical observer, and the freedom of an independent student of public affairs, who is but little trammeled by patriotic prejudice. The import of the question at the present time is thus stated: "The era of elective government has come, and in the wise ordering of it so as to give public reason the upper hand, and to reduce, as far as possible, the influence of passion, class interest, selfish ambition, faction, and corruption, lies the political hope of the world."

But Professor Smith then proceeds to show that, though the era has arrived, the thing it has brought is very different from the thing expected. It was long believed that if the rule of monarchs could be got rid of, and the rule of the people established, all the evils of bad government would be swept away. But experience has not justified this pleasing anticipation. The king has disappeared, and the people are assumed to be sovereign, but misgovernment continues, with even an aggravation of some of its worst vices. Our country revolted against hereditary rule, and put in its place elective government by the people; but, instead of a true elective system, giving fair expression to the popular will, we have got party government ruling systematically by caucus machinery, and defeating both the will of the people and the proper objects for which government exists.

Professor Smith characterizes government by party as a vicious agency, and enforces his view by convincing illustrations of its working in different circumstances; he also points out the policy which he thinks will have to be adopted if the evils of the system are to be abated or remedied. Of this policy we express no opinion: what most concern us here are the defenses that are offered for the continuance of party government; and our interest in these defenses is chiefly because of the scientific considerations they involve.

We are told that political parties are the necessary means of carrying on free popular government, and that they are but combinations of men united to achieve important measures of national

policy. The vindication of party by Edmund Burke has become classical, and Professor Smith quotes him as thus defining it: "Party is a body united for promoting by their joint endeavors the national interest upon some particular principle on which all are agreed." But this ideal of a political party is far enough from corresponding to the present reality; and it is an ideal now becoming increasingly impossible of realization. Instead of rallying around principles and carrying them out to victorious application, our parties eliminate them as incumbrances and impediments to success. In popular politics, questions of principle have been found simply "unavailable." Questions of political principle are never raised except to be settled, reduced to practice, and passed by. Conflicts of this kind must be ever coming to an end; but the end of conflict is the death of the parties to it. By the instinct of self-preservation, therefore, political parties will not identify themselves with transient measures the success of which destroys them. Politicians want perpetual power, and, although they talk principles abundantly in their convention-platforms, it is only for effect—they are not to be hampered by them.

But there are other and deeper reasons why questions of principle can not be made the basis of party government, and reasons to which every succeeding year lends additional force. The theory implies that there are, and will always continue to be, great issues of practical moment on which the people will so divide as to perpetuate the party system. But there is by no means an interminable supply of such fundamental questions as will serve the purpose; and as we have seen, under an honest pursuit of the policy, they become fewer and fewer. Professor Smith assures us that in Canada the stock of serious political issues is already exhausted, and that consequently "the two parties there are simply two factions fighting for place with the usual weapons, and poisoning the political character of the people in the process." But, if we have similar results in this country, it is certainly not from lack of paramount questions of public interest not yet settled. The difficulty is, that the community can not be bisected on such questions, as required by practical partisanship. That system demands that the people shall be divided, and remain divided into proximately equal parts that shall be totally opposed to each other, one half denying all that the other half affirms. It is founded upon disagreement, and implies that radical and comprehensive disagreement shall be the normal and permanent thing.

But it is no longer possible to constitute political parties on this basis. The whole tendency of modern ideas is in the opposite direction. The scientific spirit of the age is a force to be here counted on, and it is an agency that leads men to agreement. The increase of knowledge and the progress of intelligence, by settling principles and harmonizing opinions, must more and more disconcert party arrangements. As men learn to think for themselves, and prize truth as the object of honest thought, they will not range themselves on questions of principle in ways to suit party manipulators. No man can study political and social principles in the true scientific spirit without acquiring earnest and conscientious convictions, which will make him more and more revolt against the insincerity and utter hollowness of our partisan politics. There may be scientific men who are also party politicians; but it will generally be found that in such cases their science is far removed from the sphere of political thought.

The scientific spirit is, therefore, in broad and clear antagonism to the partisan spirit in politics, and, as the law of science is progress, who shall assure us that this is not the agency

that may ultimately destroy the pernicious system now so widely deplored, but from which escape is generally held to be most hopeless? Professor Smith well observes: "Such an agreement as would be fatal to the standing organization of civil discord is by no means out of the question; to it tends the advance of political science and the scientific spirit generally, which, gradually making its way in all spheres, is not likely to leave politics untouched. . . . In fine, as has been already said, the best and indeed the only possible form of government, if the advocates of party are to be believed, is one, the foundation of which must inevitably be weakened by every advance of the public intelligence, and which the attainment of truth on the great political questions will bring utterly to the ground."

FREE CIRCULATING LIBRARIES.

In that great work of popular education to which the present age is committed, the importance of books and libraries is sufficiently recognized, although the practical measures for making these instrumentalities available are, as yet, far from being perfected. The object has hitherto been, rather to get together extensive collections of books, with as many as possible that are rare and expensive, and place them in monumental buildings, that may be at the same time ornaments to the town and memorials of the munificence of founders and donors. Such institutions are invaluable, but they are by no means adequate to do the most important work which libraries are capable of accomplishing. They meet the wants of scholars, of people of leisure and cultivation, and they are also generally available to all classes who prize books sufficiently to take a certain amount of trouble in obtaining them. But there is a very large portion of the population in cities who from various causes are practically hindered from making use of these large libraries. To multitudes the expense of membership is a serious objection, and there are other multitudes who are both capable of reading and willing to read, but who do not care enough about it to make the little effort necessary to render such libraries useful to them. They are indifferent, perhaps dull, and can only be reached by removing every possible impediment to the procurement of books; and it is this class, moreover, which most needs the improvement that may be obtained by habitual reading. Of our common-school system this, at any rate, may be said, that it teaches the mass of the people to read, and thus brings them to a point where further cultivation is possible; but if it has been necessary to resort to compulsory education to overcome the disinclination for even learning to read, it is surely a matter of moment to make the utmost possible provision for the general encouragement of the habit of reading as a means of continued mental cultivation.

Influenced by such considerations, a few persons have recently combined, in New York, to take an efficient step in this direction. They began in a small and experimental way, but the results of the trial they have made have been in a high degree satisfactory and promising. Rooms were taken in Bond Street, and a few books collected—some by purchase and some by donations—to be lent out free of expense to anybody and everybody who wished them, the only requirement being that some reference should be given, to satisfy the librarian that the borrower had a fixed residence. It was no sooner known that books were thus obtainable, than the applications for them increased until they met the full measure of the supply, and the effort was proved in every respect successful. In the report of the trustees, recently issued, it is said:

> The library now contains 5,085 volumes. A very large proportion of these have been contributed by friends of the library, and

probably one third of the whole number have no contemporaneous value, and are rarely used by the patrons of the library. It is nevertheless found that the whole number of volumes circulated during the year is 69,230; and, assuming that the number of available books in the library is 4,000, these figures would show that each volume has been circulated over seventeen times. This percentage of usage is most gratifying, and, when compared with the returns from other libraries, may justly be pronounced extraordinary. It also appears that but sixty-four per cent of the circulation is of works of fiction—a much smaller percentage than in other libraries; while out of the whole number of books circulated during the year but *six volumes have been lost*.

The reading-room is also a demonstrated success. The total number of readers was 9,605, and they are found chiefly to belong, together with the great majority of the patrons of the Library, to that very class in the community which it is most desirable to furnish with wholesome intellectual food, and which it was hoped might be reached by this library, namely, young persons of both sexes between the ages of fourteen and twenty-one years. The publication of bulletins—that is, lists of works, or newspaper and magazine articles, upon the more important subjects which from time to time come before the public—has been continued, and the suggestions made in them are found to be quickly and generally used.

So unexpected and so encouraging are these results that they have naturally created a desire to extend the benefits of the undertaking, and it has accordingly been proposed to carry out the plan systematically by the establishment of free circulating libraries in various parts of the city, so as to make them readily accessible to all the population. In regard to this project, it is further remarked in the report:

> The trustees have carefully considered what has seemed to them as the best means of conducting the work of the society, and have decided upon a general system by which the most good should result to those requiring their aid. It is proposed to establish small libraries, located in the centers of the poorest and most thickly-settled districts of the city. The books are to be selected with special reference to the wants of each community, carefully excluding all works of doubtful influence for good. Reading-rooms would be attached to each circulating library; and, as the libraries are to be small, readers will be able to receive more than the usual attention at the hands of the librarians.

In furtherance of this idea, a public meeting was recently held in the hall of the Union League Club, presided over by the mayor, in which several of our most eminent public men made interesting addresses upon the subject. Dr. Hall gave the project his cordial approbation, and spoke ably and impressively of the need there is to carry out, on a liberal scale, an enterprise that will be productive of great good and of good alone. He referred to the discontent and agitation among the poorer and laboring classes which are liable to take a dangerous form under the misguiding influence of visionary social theorists, and for which the only remedy is the wider diffusion of sound information among the people. Mr. Joseph Choate also spoke effectively in behalf of the enterprise. He called emphatic attention to the destitution of wholesome reading-matter on the part of the great mass of the city population, and which is but very partially realized by people who have been brought up in the midst of a superfluous abundance of books. He showed how inadequate, and impracticable for popular use, are our present library facilities, and he made a vigorous appeal for the opening of the free circulating libraries on Sunday—the only leisure day of the working-classes, and the day on which they are most exposed to the temptation of questionable places of resort. Other speakers followed, urging the claims of this popular library system upon the attention of men of wealth, and asking for it so generous a support that the trustees will be able to carry out their plan promptly and effectively.

HENRY W. BELLOWS.

THE death of Dr. Bellows, so unexpected, and while yet apparently in the full vigor of his remarkable powers, is not only a painful shock to his numerous friends, but will be widely felt as a public calamity. He has been for many years prominent and influential in the management of important philanthropic movements, and he has also been the virtual head of perhaps the most cultivated, and certainly the most liberal, of the religious denominations of the country. We have no design here to give any account of his life and labors, the task having been already well performed by the newspaper press. But there was one aspect of his mental character to which it may be proper for us to bear testimony.

Dr. Bellows was a man of great independence of thought, and, though practically the leader of a religious sect, and profoundly interested in maintaining and extending its organizations, he was yet deeply interested in the most radical tendencies of inquiry. He sympathized with the spirit of thoroughgoing research in every field of investigation, with an assured faith that, so long as truth is earnestly sought, the results must always be beneficent and valuable. In a very recent conversation with him, he spoke of having read with great pleasure, and a very considerable degree of accord, the new work of Renan, "Marcus Aurelius," the last of that author's series on the "Origins of Christianity." He also referred to Spencer's "Data of Ethics," which he had carefully read at the time of its appearance, and expressed much interest in the author's further elucidation of the subject. He said, in substance: "I accept that work as a very important contribution to ethical science, and I am fundamentally in agreement with it. There are parts of it that need further clearing up, and that I could better appreciate if I were more familiar with the scientific evidence of the doctrine of evolution. But Spencer's main position, that morality must be grounded in nature, and its principles confirmed by an extending knowledge of nature, it seems to me, is impregnable; and he has certainly gone far toward constructing a stable basis of ethical doctrine."

We mention these facts to show that Dr. Bellows did not share the alarm felt by many at the progress of rationalism; that he was hospitable to advanced opinions, even in his own sphere of thought, and welcomed and prized them as hopeful indications of a sound and healthful progress in the higher departments of philosophic inquiry.

LITERARY NOTICES.

URANOMETRIA OF THE SOUTHERN HEAVENS. Brightness and Position of Every Fixed Star down to the Seventh Magnitude, within One Hundred Degrees of the South Pole. By BENJAMIN APTHORP GOULD. With an Atlas. Buenos Ayres: Paul Emile Conti. New York: D. Appleton & Co. Pp. 383. Price, $20.

IN the excellent sketch of Dr. Gould which we publish, a reference will be found to his recent contributions to the astronomy of the southern hemisphere. At the invitation of the Argentine Republic he established and assumed charge of the observatory at Cordova in 1870, and took with him from this country four assistants to aid in carrying out the grand project of fixing the positions and grades of brightness of all the southern stars visible to the naked eye at his station. The work thus taken up was an extension to the southern heavens of the system of observations made by Argelander, of Bonn, upon the northern heavens, and published in 1843 in his celebrated "Uranometria Nova." The work of Argelander represents 3,256 stars from the first to the sixth magnitude, which are to be seen above the horizon of Bonn. Dr. Gould's problem was to extend this enumeration over the whole southern sky, keeping accurately to Argelander's standard. But the extraordinary transparency of the southern atmosphere makes visible grades of stars which can not be seen in the North;

that is, stars can be seen at Cordoba, which have less than four tenths of the light of the faintest of Argelander's stars. There are 10,649 stars visible to the naked eye at Cordoba, and of these 8,198 are given in the catalogue and in the maps of Dr. Gould.

The work before us consists, first, of a full description of the methods of observation and the stellar phenomena of the southern heavens, and this is followed by a tabulated catalogue of the stars. It is accompanied by a large atlas of fourteen charts, which "gives an exact pictorial representation of the state of the sky at the epoch of the work. Besides giving a representation of the isolated stars, the shadings and gradations of the milky way are given with the greatest detail from repeated observations and revisions."

These stellar maps, though South American work, are executed with great beauty and perfection. The obstacles in the way of their production were very formidable, and the genius of Dr. Gould is perhaps as much seen in the skill and perseverance with which he overcame them as in the scientific faithfulness of the labor and the artistic finish of the machanical results. The whole of the printing was executed at a distance of 500 miles from Cordova, and the proofs, frequently requiring three and four corrections, had to be passed backward and forward with long delay, so that the project, which should have been completed in 1877, actually required two years longer. The quarto volume containing the catalogue is in the Spanish and English languages, side by side in double columns.

The production of such a work, of course, involved very heavy expenses, which were liberally met by the Argentine Government. A few copies have been left on sale with D. Appleton & Co., at a comparatively nominal price, for the use of such observatories, libraries, and astronomers as may desire to procure them.

AN EXAMINATION OF THE LAW OF PERSONAL RIGHTS, TO DISCOVER THE PRINCIPLES OF THE LAW. By A. J. WILLARD. New York: D. Appleton & Co. 1882. Pp. 429. Price, $2.50.

THIS is a work written by a lawyer, and, it may be assumed, written mainly for lawyers, although it claims to have an interest for a wider circle of readers. There are two great categories of law: those regularities of process in things around, which we call laws of nature and which execute themselves; and those rules of conduct laid down by civil authorities as laws of society, and which are executed by the machinery of government. The term law, as thrice used in the title-page of this book, belongs to the latter category—that is, to statutory regulations. Now, it has ever been a problem of great interest to find out the relations which these two systems of law sustain to each other, and this seems to be the fundamental question to which Judge Willard has addressed himself in the preparation of this volume. Although, as a discussion of the principles of personal rights, and the general policy of law in connection therewith, the treatise has practical claims upon the legal profession; yet its broader interest is to be found in the author's attempt to affiliate the system of law upon the natural conditions of society. The idea of the law which the work endeavors to bring into view and illustrate, by an examination of the present body of law, is that legal ordinances are but a formulation of those habits of a community that are essential to the continuance of social life. Judge Willard repudiates the idea, which he holds to be widely entertained, that law is nothing more than a set of merely arbitrary rules. "In every community of men," he says, "the habits of its individuals constitute a general law. These habits have been mainly derived by heredity, modified by various means. Certain tendencies have taken forms more or less developed in their habits, and still continue to operate as modifying causes in the further development of habit. So far as these habits are essential to maintain the social state, and attain its ends, they are imperative, or assume the form of law—that is, are embodied in the common will. Beyond this there must be an authority to select the means of maintaining the society, and the ends it shall pursue, and to prescribe the conduct of individuals in reference to the community and to each other. This is the public law of society. Though recognizing that law is a growth, the author is not here concerned with tracing out its

development, and showing how successive forms grew out of those preceding, but with showing that the present body of law conforms in its essential features to the fundamental requirements of the social state of man. It is impossible to sum up in any satisfactory way the theoretical reasons of so comprehensive a work within the limits of a book notice. We can only say that the writer claims to occupy new ground, and to place the subject of public law on the same footing as the natural sciences. Certainly no task is more important than to show that the system of enactments by which society is regulated and the conduct of individuals controlled is not arbitrary, irrational, and chaotic. But the chief value of Judge Willard's book will no doubt be found in its usefulness to the students of law. He deals with a long series of specific subjects presented in forty chapters, and covering the whole comprehensive ground of personal rights and social obligation. The first chapter is on the origin of law, and the next on the nature and origin of rights, obligations, and powers. Chapter X takes up the science of law, Chapter V is devoted to the "proper subjects of contracts," and the following chapters develop the conditions of contracts in various aspects. In succeeding chapters a great variety of subjects are treated, throwing light upon the legal position of the individual, and the latter portion of the work is much devoted to what may be called the modern liberties, or those higher prerogatives of the citizen which it is the object of free governments to secure. In the closing chapters, marriage, the family, and communal associations are considered; and the final discussion treats of the liberty of judgment and the liberty of self-gratification. Judge Willard has not given us a book of formal erudition; it contains no notes, and we have not observed that it refers to any authorities. It is rather an analytical work, occupied with the development and application of principles.

THE FIRST-BOOK OF KNOWLEDGE. By FREDERICK GUTHRIE, F. R. S. New York: G. P. Putnam's Sons. Pp. 130. Price, $1.

OF this little book we can say emphatically, Yes! and No!

It is a most interesting and readable compend of information on all kinds of familiar objects, such as we find in and around the house, and that everybody ought to know about. The subjects are selected with excellent judgment; the knowledge is important and trustworthy; and it is simply, concisely, and agreeably presented. In all these respects the volume is a model; and, when we add that there are questions at the end of each chapter to help the teacher, and that the teacher is exhorted to bring as many of the objects into the school-room as possible, for the inspection of the children, and to add as many questions as may be to those already given, it will naturally be asked, What more can be required?

Certainly nothing more is required on the accepted school-book standard; but we question the validity of the standard. The book is made on the old theory of pouring the facts into the little mental pitchers until they are full. But that is not the true idea of education; and therefore, as a "First-Book," it starts wrong. A book treating of "objects" that does not provide, first of all, and as the essential thing, for the active effort of inquiry on the part of the pupil, and that he shall find out the properties of objects for himself, fails of its purpose as a means of education. Such failure has, of course, been the rule in our past school-history; but it can be no longer excused, and we confess to some astonishment that a book of this quality should emanate from a distinguished professor in a "normal school of science." South Kensington is getting behind the age if this is the best that its "normal science" can do.

ECCE SPIRITUS. A Statement of the Spiritual Principle of Jesus as the Law of Life. Boston: George H. Ellis. Pp. 238. Price, $1.25.

THIS work has largely in view the discrepancies between the theological and the scientific thought of the age. The author distinguishes three types of religious thought. The first type is illustrated in that class of persons "who ensconce themselves in a quiet corner of the church, away from the din of the controversies which distract the age," and who are indifferent to the vast changes that have come over the modes of thought; the second type in the class who stand at the other extreme, ac-

knowledge no authority outside of matter and the mentality that is coextensive with it, reject faith, and rest content in the nice processes of rationalization; and the third type, in a class between the other two, who, satisfied with neither of the above positions, "are rationalistic in method and in sympathy with every negative result that has been wrought out by the study of the facts, and yet unwilling and unable to rest there. With no fear of science, and all due respect for its wonderful work of revelation, they are conscious of something in them more real in fact, and more satisfactory in recognition, not yet accounted for. Whatever the failure of current Christianity to harmonize these two apparently antagonistic positions, they are not wholly without hope of a possible meeting-ground between faith and fact." To those persons especially, who constitute a large proportion of earnest, thinking people all over the world, the book is directed.

THE LAND OF THE WHITE ELEPHANT: SIGHTS AND SCENES IN SOUTHEASTERN ASIA. A Record of Travel and Adventure in Burma, Siam, Cambodia, and Cochin-China. By FRANK VINCENT, author of "Through and Through the Tropics," etc. New and enlarged edition. New York: Harper & Brothers. Pp. 375. Price, $3.50.

THE present edition is about one half larger than the original work, which was already fairly well known as a most agreeable and life-like account of the countries to which it relates, of their geographical characteristics, people, governments, customs, and antiquities. The most valuable part of the added matter is that included in the third chapter of the supplement respecting Cambodia, of whose ruins, attesting to the former existence of a high civilization, Mr. Vincent's was already the most satisfactory and adequate, and the first account, except a too brief reference in the book of Mrs. Leonowens, that has been published in the United States. Concerning the interest attached to these ruins Mr. Vincent says, in a private note, that "not even the excavations which have shown to us the buried cities of Greece and Cyprus have thrown more light upon the perfection attained by Eastern art than have the splendid and stupendous ruins found in the interior of Indo-China. But, though the degree of Oriental art has thus been made plain, absolutely nothing is known concerning the people to whom the original structures are due." Since he first made known to his countrymen the character of these ruins seven years ago, he has devoted much time and study to the general subject of Indo-Chinese antiquities, with special reference to the solution of the problems when and by whom the Cambodian cities were built; where the homes of the descendants of their builders are now; and to what form of worship their temples were dedicated; and the results of his researches are set forth, in a condensed form, in the chapter we have mentioned. He assigns a late date (the fourteenth century) to the building of the Nagkon Wat, believes that it was intended for Buddhist worship, and suggests that the Cambodian monuments and those of Yucatan, between which there is some resemblance, may have been contemporaneous, and possibly the work of branches of the same race. Other theories look for a connection between Cambodian and ancient Assyrian works; and it is evident, from what Mr. Vincent says, that, until further and more exact explorations are made, there will be no end to the conjectures for which some plausible support may be found. This only makes it the more desirable that the works should receive immediate scientific attention.

THE HONEY-ANTS OF THE GARDEN OF THE GODS, AND THE OCCIDENT ANTS OF THE AMERICAN PLAINS. By HENRY C. McCOOK, D. D., author of "The Agricultural Ant of Texas," "The Mound-Building Ant of the Alleghanies," etc. Illustrated with Thirteen Plates. Philadelphia: J. B. Lippincott & Co. Pp. 188. Price, $2.50.

DR. McCOOK started in 1879 to observe the honey-ants in New Mexico, but found them in the Garden of the Gods, in Colorado, and stopped and studied them there. He is able to extend the territory of their natural habitat, so that it shall include Mexico, New Mexico, and Southern Colorado. The characteristic of the species is that, in one of the castes or worker forms, the abdomen is distended to the size and form of a currant or small grape, and is entirely filled with grape-

sugar or honey. These ants apparently prefer elevated situations, but doubt is thrown over this by their having been mentioned as seen at Matamoras, which is but little above the level of the sea. Their nests are built on the tops of the ridges, and are marked externally by small moundlets of gravel six or seven inches in diameter, and two or three inches high; internally they present ramifications of galleries and enlarged chambers in several stories, within which the honey-bearers exist, clinging to the roof of the vault. The honey is gathered by another class of workers from the galls of a species of oak, where Dr. McCook found it in the shape of globules which had been exuded from the gall, and is conveyed to the honey-bearers by regurgitation. It is "very pleasant, with a peculiar aromatic flavor, suggestive of bee-honey, and quite agreeable." Dr. Loew also describes it as having an agreeable taste, slightly acid in summer from a trace of formic acid, but perfectly neutral in autumn and winter. The sirup extracted from the ants had an odor like that of the sirup of squills, and dried, when heated, into a gummy mass, which quickly became soft by the absorption of water from the atmosphere, and the alcoholic solution of which had the smell of perfumed bay-rum. The honey is gathered by the Mexicans and Indians, is eaten freely and regarded as a dainty morsel, and is fermented into an alcoholic product. It can never be got in large enough quantities to make it of economical value, even if that were desirable. The ants, showing the same traits as all other species that have been observed, take most excellent routine care of the honey-bearers and of the larvæ, but seem wholly indifferent to occasions calling for care or sympathy which happen to be out of the regular line. Their chambers are constructed with the architectural skill that is shown by their making the floors perfectly smooth, so that their progress and work shall be facilitated as much as possible, and by their making or leaving the roofs rough, so that the honey-bearers may cling more securely to them. The occident ant is the most numerous species of animal on the Western Plains, and, after the prairie-dog, affords the most prominent marks of its presence everywhere on their surface; yet Dr. McCook's memoir, forming the second half of this volume, is the first that has been published about them. Their habits are similar to those of the harvesting ant of Florida, the agricultural ant of Texas, and some harvesting ants that have been observed in Pennsylvania and New Jersey. They have been found from Brookville, Kansas, to Reno, Nevada, through twenty-one degrees of longitude, and range probably from 32° to 45° north latitude. They build their nests, which are marked by elliptical cones sometimes ten inches or a foot high, in slopes and flats, avoiding the ridges. The mounds are surrounded by cleared spaces which are sometimes ten feet or more in diameter, and appear to have been purposely stripped of vegetation, while the surrounding grass is penetrated by paths leading out. All of the mounds are covered with pebbles of the nature of the gravelly soil in which they stand, which appear to be collected by the ants and brought to the spot, if necessary. One of the insects was observed to carry a stone of six times its weight over a space of three hundred times its length and up inclines. These ants are evidently harvesters, gathering seeds and storing them in their nests, which are chambered under-ground, sometimes to a depth of eight or nine feet, and are not essentially different in their interior construction from those of the honey-ant. Dr. McCook observed them gathering seeds of the sunflower, of a euphorbia, of an amaranthus, of the gramma-grass of the country, and of other plants. Their nests are infested by six or seven species of parasitic ants, toward which they show no liking, but no particular hostility, of two of which, the erratic ants and the fetid ants, an interesting account is given. Dr. McCook confines himself to relating and illustrating the facts he has observed, leaving inferences to be drawn by others; and he has made a valuable addition to the literature of a subject that engages the attention of the most distinguished naturalists.

SUICIDE: STUDIES ON ITS PHILOSOPHY, CAUSES, AND PREVENTION. By JAMES J. O'DEA, M. D. New York: G. P. Putnam's Sons. 1882. Pp. 322. Price, $1.75.

THE author defines suicide as the intentional destruction of one's own life, and excludes from the category deaths from acts

or lines of conduct which, howsoever much opposed to self-preservation, are not intended to destroy life. The questions relating to it are partly social, partly medical. It presupposes two necessary conditions: 1. Moral and physical impressions derived from without; and, 2. On the part of the recipient of these impressions, a nervous impressibility, which not only magnifies and distorts them, but which gives them a dangerous power to affect his happiness. Hence the causes of suicide naturally fall under two main divisions—the external or social, and the internal or personal. The general external causes exist everywhere and under all circumstances, and have their sources in extravagant religious and moral beliefs. Special external causes comprise all those various circumstances and accidents which result from the relations of individuals to each other in society. The internal or personal causes include ill health, insanity, and temperament. All these influences are set forth in the present volume. For the prevention of suicide, the author proposes legal measures, religious and moral training, and medical advice and treatment.

THE NATURE AND FUNCTION OF ART, MORE ESPECIALLY OF ARCHITECTURE. By LEOPOLD EIDLITZ, Architect. New York: A. C. Armstrong & Son. Pp. 493. Price, $4.

MR. EIDLITZ is an architect whose works attest his accomplishments and his competency to discuss the subject. He believes that, while all other branches of art are alive and advancing, something is wrong in the condition of that branch to which he is devoted; that, while the mechanic art of building never stood higher than now, architecture itself, alone of the arts, is silent, or rather has ceased to speak of living ideas. To inquire into the causes of this condition, and to define the nature and function of art in general and of architecture in particular, so as to show how it may again become a living and creative art, is the object of this volume. Mr. Eidlitz combats the idea that taste is the quality which enables men to produce works of art, or even to judge them, or that common sense alone is a safe guide. In all other branches of knowledge, study and acquaintance with technical principles are considered essential to even a fair degree of proficiency. So it is with architecture. The evil effects of too great reliance on taste, and too little attention to training, are illustrated in the ill-adapted buildings that we meet everywhere and that are still growing up around us, the multiplicity of which gives point to the author's remarks respecting the present condition of the art, that "it appears to be the accepted opinion that the sole function of architecture as an art is to make monuments pleasant to behold; that this may be done in any way which to the author of the monument may promise good results; that it is useless to seek for a clew to all this in the organism of the monument itself, or in the nature of the idea which has called it into existence, or to seek to establish an organic relation between the ornament and the structure. That such a looseness of definition of the nature of architecture," he adds, "must lead to false conceptions and to other illogical reasoning must be apparent." Mr. Eidlitz's own view is, that it is the province of architecture to express ideas by structures—a principle that may be illustrated by showing that "if a man tries to build a house which shall be as good as he can afford to make it; if he does nothing for show, and everything for structural integrity; if he builds it so that it may serve his purpose—then his house will be a monument to his purpose." In order to create a monument it is necessary that its author should be conscientious, and that he should respect the thing he is doing. He should not resort to mechanical expedients, no matter how sound in themselves, because they are desirable only on economical grounds, if they are lacking in, or detrimental to, clear art expression. Self-denial should be exercised in refraining from unmeaning display for the sake of show; there is no beauty but that which results from a forcible, clear, and successful expression of the idea in matter, and this must depend on the amount of character in various features of the structure. And, finally, "in creating a monument, the problem is mainly to give expression to the acts performed within its walls, which is done by giving the structure a form which will correspond with the groups performing those acts, and to its parts such masses, modeling, carved and color decora-

tion as will express precisely the degree of stability, dignity, and elegance which corresponds with the import of the acts to be expressed." The architecture of the past, the vague ideas of writers, and the aimless practices of the present, are reviewed and criticised in the light of these fundamental principles, and the conclusions are reached in the end that the dilettanteism of modern architecture must be rooted out before the art can revive and exercise a wholesome influence on society; it must be understood that "the road to architecture is long, tortuous, and thorny, and not a well-paved highway upon which man may amble into fame"; false taste has had its day, and *style* must also be cast off, when "nothing will be left but to pursue architecture pure and simple."

DANGERS TO HEALTH: A PICTORIAL GUIDE TO DOMESTIC SANITARY DEFECTS. By T. PRIDGIN TEALE, M. A., Surgeon to the General Infirmary at Leeds. Third edition. Philadelphia: Presley Blakiston. Pp. 170. Price, $3.50.

THE author, having discovered and rectified numerous defects in his own house, and having traced illness among his patients to carelessness and dishonesty in drain-work, became "indignantly alive to the fact that few houses are safe to live in." He was convinced also that a large fraction of the incidental illness suffered in England, including much childbed illness and some of the fatal results of surgical operations in hospitals and private houses, were the direct result of drainage defects. He then sought for the most impressive way of describing faults of this class to the public, and chose that of pictorial representation. The result is this work, which contains seventy plates representing nearly as many important faults to which domestic sanitary arrangements are liable, with letterpress explanations of the same, as well as of some other faults not so susceptible of pictorial representation. The illustrations are designed to give the most forcible expression possible of the fact to be told, and are clear and distinct as to their meaning. Three of the drawings are designed as hints toward securing adequate ventilation and the exclusion of dust.

A STUDY OF THE PENTATEUCH, FOR POPULAR READING. By RUFUS P. STEBBINS, D. D., formerly President, Lecturer on Hebrew Literature, and Professor of Theology, in the Meadville Theological School. Boston: George H. Ellis. Pp. 233. Price, $1.25.

THIS book embraces the substance of some articles which were published in the "Unitarian Review" in 1879 and 1880. The first paper is a review of the attacks of Dr. Kuenen, one of the most brilliant and reckless of the Dutch rationalistic critics on the authenticity of the Old Testament Scriptures. The other essays embody the author's own examination of the books of the Pentateuch, with reference to their authenticity, in respect to the external evidence, or that afforded by the references to them and quotations from them made by a succession of Hebrew writers from David to Josephus; and the internal evidences, or those afforded by the style and methods of expression of the books themselves, and the allusions contained in them as indicative of the time when they were composed. The definite conclusion is reached that the Pentateuch is substantially of the Mosaic age, and largely, either directly or indirectly, of Mosaic authorship.

THE OPIUM-HABIT AND ALCOHOLISM. A Treatise on the Habits of Opium and its Compounds, Alcohol, Chloral-Hydrate, Chloroform, Bromide of Potassium, and Cannabis-Indica. By Dr. FRED. HEMAN HUBBARD. New York: A. S. Barnes & Co. Pp. 259. Price, $2.

IT is believed that the opium-habit is increasing in the United States with frightful rapidity. It has spread much faster since the introduction of the hypodermic syringe, and has reached an extent which is partially represented by the payment of five million dollars annually for the drug, and by the estimate that there are now not less than 500,000 consumers in the country against 225,000 in 1876. The object of the author of this work has been to place in the hands of the profession a carefully arranged analysis of the peculiar physical condition induced by the indulgence of the habit, with descriptions of the symptoms that appear and the changes that take place under treatment. This is done by the presentation of accounts

of typical cases. The effects of stimulants on the functions of the system, and certain diseases, are also considered. And, as relating to the same class of habits or affections, the author also discusses the dementing effects of bromide of potassium when taken habitually, and the treatment of the "bromide-habit," the treacherous and subtile tendencies of chloral, chloroform and the means of warding off its dangerous effects, and the pathology and treatment of dipsomania. The subject of favorable surroundings for patients while undergoing treatment is also considered, and the inquiry is made why, as the author believes, "inebriate asylums and sanitariums have made so signal a failure in their efforts to reform the fallen." The book has neither table of contents nor index.

THE AUTOBIOGRAPHY OF MARK RUTHERFORD, DISSENTING MINISTER. Edited by his Friend REUBEN SHAPCOTT. New York: G. P. Putnam's Sons. 1881. Pp. 218. Price, $1.

AN uncompleted story of the life and troubles of a man who appears to have been of morbid disposition, who was always struggling with doubts, the victim of questions coming up in the course of his discharge of his duties, which he could not solve. The regulation theological education which he received at the seminary of his sect was not adapted to its immediate purpose, much less to enable the student to face the popular and speculative thoughts of the day. He was, therefore, thrown upon the world unprepared to engage in its intellectual struggles, and was perpetually tormented by the presentation of difficulties "which haunted his whole existence and prevented his enjoyment of it."

THE LEAGUE OF THE IROQUOIS, AND OTHER LEGENDS FROM THE INDIAN MUSE. By BENJAMIN HATHAWAY. Chicago: S. C. Griggs & Co. 1882. Pp. 319. Price, $1.50.

THE author believes the legends of the Indians embody the essentials of religious truth, and are to them what the Eddas were to the Scandinavians, their mythology to the Greeks, the story of Buddha to the Hindoos and Mongolians, and the teachings of Christ to the Christian world. He finds in them a central idea, of a Divine Man of miraculous birth and superhuman attributes, who was sent among the red-men from the Great Spirit to subdue the monsters of the forest and rivers, and teach them their arts; and that it is right to judge the character and capacity of the Indians in the light of this conception as we measure civilized peoples by their highest attainments in art, science, and literature. The present collection of poems is an attempt to give in an intimately related series of pictures the story, as embodied in the Iroquois tradition, of the origin of the confederation, "and, especially, all that relates to the part the great personage of Indian mythology—Ha-yo-went-ya—took in the formation of the league."

ZOÖLOGICAL ATLAS (including Comparative Anatomy), with Practical Directions and Explanatory Text, for the Use of Students; 231 Figures and Diagrams. By D. MCALPINE, F. C. S., author of a "Biological Atlas," etc. Vertebrata. Edinburgh and London: W. & A. K. Johnston. 1881. Twenty-four Plates, with Explanations.

THE object of this work is to help the student in the explanation and dissection of the leading forms of animal life. It is intended to be employed on the principle laid down by Professor Macalister, of Dublin University, that "it is only by the examination of specimens that any knowledge of the science worth acquiring can be obtained, and the function of a book is to assist in practical study." The illustrations, which are colored, represent the various points to be noted in the dissections, showing the details of anatomical structure and their relations, and are accompanied by suitable and brief explanations. The six types of vertebral life are represented by a specimen selected with reference to its convenience of size for handling and the facility of procuring it; the cartilaginous fishes by the skate, the bony fishes by the cod, the tailed amphibians by the salamander, reptiles by the tortoise, birds by the pigeon, mammals by the rabbit. The plates in their several series show the external and internal characters of the animals, the skeleton, nervous and sense organs, alimentary system, the circulatory, respiratory, and other organs.

THE VERBALIST: A MANUAL DEVOTED TO BRIEF DISCUSSIONS OF THE RIGHT AND THE WRONG USE OF WORDS. By ALFRED AYRES. New York: D. Appleton & Co. 1882. Pp. 220. Price, $1.

THERE can be no doubt concerning the importance of using the right words in the right places; and any guide which approaches the subject in the right way and in the right spirit is of value. Mr. Ayres has given such a guide. He does not assume to be an authority, but a student of authorities and a representative of them. Following a strictly alphabetical arrangement of words and topics in regard to which a wrong usage exists or authorities differ, he gives in brief what the authorities declare about each, with their differences where they differ; and, while he does this with apparent impartiality, he is not afraid to add his own view, which, so far as we have noticed, is the one agreeable to reason and common sense. As a whole, "The Verbalist" is equal to the best of the small works in this department.

NEW SYSTEM OF VENTILATION, WHICH HAS BEEN THOROUGHLY TESTED UNDER THE PATRONAGE OF MANY DISTINGUISHED PERSONS. A Book for the Household. Fourth edition, enlarged, with New Illustrations. By HENRY A. GOUGE. New York: D. Van Nostrand. 1881. Pp. 176.

MR. GOUGE'S system of ventilation has been in use for several years, and has given general satisfaction as a cheap, simple, and effective method of solving the problem. It is adapted for any of the twenty or more kinds of buildings and apartments which he enumerates in his title-page, and can be applied with but little alteration of plans. The present volume gives an explanation of its operation, and a selection of miscellaneous paragraphs on the need of ventilation, good and bad ventilation, and the defects of modern buildings and modern life generally in respect to the subject.

CELESTIAL OBJECTS FOR COMMON TELESCOPES. By the Rev. T. W. WEBB, M. A., F. R. A. S. Fourth edition, revised and greatly enlarged. New York: Industrial Publication Company. Pp. 493.

THIS work appears to be one of great value to amateur astronomers. Its purpose is to furnish the possessors of ordinary telescopes with plain directions for their use, and a list of objects for their advantageous employment. It begins with a description of the telescope, especially of ordinary telescopes (refractors of from three to five inches aperture, and reflectors of a little larger diameter), and directions for their practical care and use, after which are given descriptions of the sun, moon, planets, comets, and of the double stars, clusters, and nebulæ coming within the range of the class of observations contemplated. The account of the moon is accompanied with a large sheet-map, on which every point and object is distinctly marked and numbered, and that of Mars by a polar map of similar character. The chapter on double stars, clusters, and nebulæ, is arranged by constellations, under the head of which each object is specifically and separately located and described.

THE LABOR QUESTION, OR AN EXACT SCIENCE OF EQUIVALENTS; AND ALSO CONTAINING A NEW THEORY OF COSMOGONY. By AMICUS HUMANI GENERIS. Chicago: The Chicago Legal News Company. Pp. 186.

THIS is an example of the kind of work that an active mind of some ability may produce without having any of the knowledge that is gained by investigation and careful study. It offers a mixture of native ideas, some of which are good, with the utmost confusion of all that is taught by history and science. The author assumes that the great evils that afflict the world are land tenure, rents, interest, and the price of stocks—that is, all that furnishes the capital on which labor depends; and that it is the duty of labor to destroy these and establish a kind of communism. With all this he has some sound ideas on free trade and tariffs, and the spirit in which trades-unions ought to be managed.

ELEMENTS OF QUATERNIONS. By A. S. HARDY, Ph. D., Professor of Mathematics, Dartmouth College. Boston: Ginn, Heath & Co. Pp. 230.

THE object of this treatise is to exhibit the elementary principles and notation of the quaternion calculus, so as to meet the wants of beginners in the class-room; and to give them such a conception of the value and beauty of this instrument of research as

may lead them to follow the more extended application of its principles in the works of the original and leading authors.

PUBLICATIONS RECEIVED.

Report of the Joint Standing Committee on Water, on the Impurity of the Water-Supply of Boston. With the Report of Professor Ira Remsen on the Subject. Boston: Rockwell & Churchill. 1881. Pp. 22.

The Brain of the Cat. Preliminary Account of the Gross Anatomy, with Four Plates. By Burt G. Wilder, M. D. Read before the American Philosophical Society, July, 1881. Pp. 38.

A Theorem on Planetary Motion; or Sunshine and Shadow. By Clark Roberts, M. D. St. Louis: Slawson & Co., printers. 1881. Pp. 32. 25 cents.

Transactions of the New York Academy of Sciences, October, 1881. Pp. 20.

Drug Attenuation. By J. P. Dake, M. D. Nashville: Haynes & Co., printers. 1881. Pp. 35.

The Debt to Africa. The Hope of Liberia. By A. N. Bell, M. D. Reprint from "American Church Review." 1881. Pp. 28.

Sur la Distribution de l'Énergie dans le Spectre Solaire normal. Par M. S.-P. Langley. Paris: Gauthier-Villars, printers. 1881. Pp. 5.

The Indian Question. G. W. Owen. Ypsilanti, Michigan. 1881. Pp. 24.

Forestry Bulletins, Nos. 1, 2, 3, 4, and 5. Issued by the Census Office, Department of the Interior, Washington, D. C. 1881.

An Abstract of the Results obtained in a Recalculation of the Atomic Weights, by F. W. Clarke, pp. 12; and Some New Compounds of Platinum, by F. W. Clarke and Mary E. Owens, pp. 5. Reprints from "American Chemical Journal."

Twenty-sixth Annual Report of the Director of the Astronomical Observatory of Harvard College. By Edward C. Pickering. Cambridge: University Press. 1882. Pp. 16.

The Palæolithic Implements of the Valley of the Delaware. From the "Proceedings of the Boston Society of Natural History." Cambridge, 1881. Pp. 25.

Boulder County as it is. By John K. Hallowell. Published by the Colorado Museum of Applied Geology. Denver, 1882. Pp. 19. 15 cents.

On a New Substance resembling Dopplerite from a Peat-Bog at Scranton. By Henry Carvill Lewis. Read before the American Philosophical Society. 1881. Pp. 6.

No more Free Rides on this Jackass, or Protection Forever and Everywhere. By Frank Rosewater. Cleveland: Published by the Author. 1882. Illustrated. Pp. 160. 50 cents.

More Public Parks: How New York compares with other Cities. Published by the New York Park Association. 1882. Illustrated. Pp. 23.

Descriptions of some New Ichneumon Parasites of North American Butterflies. From the "Proceedings of the Boston Society of Natural History." By A. S. Packard, Jr. 1880. Pp. 38.

On the Microscopic and General Characters of the Peach-Tree affected with the "Yellows." Reprint from the "American Naturalist." By W. K. Higley, of Geneva, Wisconsin. 1881. Pp. 24.

First-Book of Knowledge. By Frederick Guthrie, F. R. S. New York: G. P. Putnam's Sons. 1882. Pp. 180. $1.

Publications of the Massachusetts Institute of Technology, and of its Officers, Students, and Alumni, 1862–1881. Compiled by William Ripley Nichols, S. B. Boston: A. A. Kingman. 1882. Pp. 50.

The Q. P. Index Annual for 1881. An Index to "The International Review," "The Popular Science Monthly," "The Century," "Lippincott's," "The Nation," "The Atlantic," "The Living Age," "Harper's," and "The Eclectic," for 1880–'81. Bangor, Maine: Q. P. Index, publisher. 1882. Pp. 56.

The Prevention of Syphilis: An Address read before the Philadelphia County Medical Society, December 14, 1881. By J. William White, M. D. Reprinted from the "Philadelphia Medical Times." 1882. Pp. 20.

The Anatomy of the Mouth-Parts and of the Sucking Apparatus of some Diptera. By George Dimmock, of Cambridge, Massachusetts. Boston: A. Williams & Co. 1881. Pp. 50. With Four Plates and Explanations.

Statistics of the Iron and Steel Production of the United States. Compiled by James M. Swank, Secretary of the American Iron and Steel Association, Special Agent of the Census. Washington: Government Printing-Office. 1881. Pp. 180.

The Viscosity of Gases at High Exhaustions. By William Crookes, F. R. S. From the "Philosophical Transactions of the Royal Society." 1881. Pp. 60. With Four Plates.

Elementary Lessons in Electricity and Magnetism. By Sylvanus P. Thompson, B. A., D. Sc., Professor in University College, Bristol. London: Macmillan & Co. 1881. Pp. 446. $1.25.

Experimental Researches into the Properties and Motions of Fluids, with Theoretical Deductions therefrom. By W. Ford Stanley. London: E. & F. N. Spon. New York: 446 Broome Street. 1881. Pp. 550.

Transactions of the Medical Association of Georgia. Thirty-second Annual Session, 1881. Edited by A. Sibley Campbell, M. D. Augusta: Joseph Loveday. 1881. Pp. 314.

Measurements of the Force of Gravity at Tokio and on the Summit of Fujinoyama. By T. C. Mendenhall, Ph. D., Professor of Experimental Physics in Tokio Daigaku. Tokio, Japan: Published by Tokio Daigaku (the University of Tokio). 2541 (1881). Pp. 17.

Geology of the Environs of Tokio. By David Brauns, Ph. D., M. D., Professor of Geology in Tokio Daigaku. Tokio, Japan: Published by Tokio Daigaku. 1881. Pp. 84. With Eight Plates.

Tokio Daigaku (University of Tokio). The Calendar of the Departments of Law, Science, and Literature. 2540–'41 (1880–'81). Published by the University, Tokio, Japan, 2540 (1880).

Lectures on the Origin and Growth of Religion, as illustrated by some Points in the History of Indian Buddhism. By T. W. Rhys Davids. New York: G. P. Putnam's Sons. 1882. Pp. 263. Price, $2.50.

The Universe: or, The Infinitely Great and the Infinitely Little. By F. A. Pouchet, M. D. Sixth edition. Illustrated by 270 Engravings on Wood. New York: G. P. Putnam's Sons. 1882. Pp. 564. $3.75.

An Elementary Treatise on Electricity. By John Clerk Maxwell, M. A. Edited by William Garnett, M. A., Oxford (Eng.). At the Clarendon Press. 1881. Pp. 208, with Six Plates. $1.90.

Sensation and Pain. By Charles Fayette Taylor, M. D. New York: G. P. Putnam's Sons. 1881. Pp. 77. 75 cents.

Aspasia. A Romance of Art and Love in Ancient Hellas. By Robert Hamerling. From the German, by Mary J. Safford. New York: William S. Gottsberger. 1882. Two vols. Pp. 685. $1.75.

Opium-Smoking in America and China. A Study of its Prevalence and Effects. by H. H. Kane, M. D. New York: G. P. Putnam's Sons. 1882. Pp. 156. $1.

Elements of Orthoëpy, consisting of the most Essential Facts and Principles. By C. W. Larison, M. D. Published by the author at Eingoes, New Jersey. 1881. Pp. 132.

Sewer-Gases: Their Nature and Origin, and how to protect our Dwellings. By Adolfo de Varone, A. M., M. D. Second edition. Revised and enlarged. New York: D. Van Nostrand. 1882. Pp. 145. 50 cents.

Books of All Time. A Guide for the Purchase of Books. Compiled by F. Leypoldt and Lynde E. Jones. New York: F. Leypoldt. 1882. Pp. 80.

A Reading Diary of Modern Fiction. Containing a Representative List of the Novels of the Nineteenth Century, etc. New York: F. Leypoldt. 1881. Pp. 150, with blanks.

The Actual Lateral Pressure of Earth-works. By Benjamin Baker, M. Inst. C. E. New York: D. Van Nostrand. 1882. Pp. 180. 50 cents.

The Mother's Guide in the Management and Feeding of Infants. By John M. Keating, M. D. Philadelphia: Henry C. Lea's Son & Co. 1881. Pp. 118. $1.

POPULAR MISCELLANY.

Fifty Years' Study of the Distribution of Plants.—Sir J. D. Hooker devoted his address, as President of the Geographical Section of the British Association, to a review of the progress that had been made during the last fifty years in the study of the geographical distribution of living (particularly of vegetable) forms. The germ of this study is to be found in an idea attributed by Humboldt and Forbes to Tournefort, that in ascending mountains the vegetation gradually approaches that of the higher latitudes. Humboldt began his botanical studies early in life, and in his "Prolegomena," published in 1815, endeavored to determine the proportions which the species of certain large families, or groups of families, bear to the whole number of species comprising the floras in advancing from the equator to the poles, and in ascending high mountains. He observed that some kinds of plants increase relatively to others in going from the equator to the poles, others diminish, while some are strongest in the temperate zones, decreasing in both directions. No material advance was made, however, toward improving the laws of geographical distribution so long as it was believed that the continents and oceans had experienced no great changes of surface or climate since the introduction of the existing assemblages of animals and plants. This belief was dispelled by Lyell, who showed, from the examples of Sicily and some of the mountain-regions of Italy, that a fauna may be older than the land it inhabits. Darwin conceived the same idea from comparisons of the living quadrupeds of Asia and America; and it was confirmed by the discovery of Arctic plants on the mountains of the temperate zone. The first attempt to press the result of geological and climatal changes into the service of botanical and zoölogical geography was made by the late Edward Forbes, who communicated to the British Association a study of the distribution of endemic plants, particularly those of the British Islands, considered under this aspect. This paper shows that Forbes was profoundly impressed with the belief that the conditions of geological connection and climate were the all-powerful controllers of the migrations of animals and plants, and induces Professor Hooker to pronounce its author "the reformer of the science of geographical distribution." Before the doctrine of the origin of species by variation and natural selection was published, all reasoning as to the distribution of species was subordinated to the idea that they were permanent and special creations. The modes of dispersion had been traced, but the origin of representative species, genera, and families, remained an enigma. The existence of the same kinds in different places could be accounted for only on the supposition that these different places presented conditions so similar that they favored the creation of similar organisms; and this failed to account for identities occurring where there was no discoverable similarity of physical conditions, and their failing to occur where the conditions were similar. Under the theory of modification of species after migration and isolation, the representation of similar species in distant localities is only a question of time and changed physical conditions. New data for the study of the past and present physical geography of the globe were afforded by the discove y in the Arctic regions of fossil plants of types corresponding with those which are now found only in warm temperate zones, which dates from 1848. These fossils proved not only to belong to genera of trees common to the forests of all the three northern con-

tinents, but to include also what are now extremely rare and even local genera. These results opened up a new channel for investigating the problem of distribution, and it was first entered by Dr. Asa Gray, who pursued it with brilliant results. Professor Blytt, of Christiania, in his essay on "The Immigration of the Norwegian Flora during Alternately Rainy and Dry Periods," invoked the glacial period to account for the dispersion of Arctic plants, dealt with a rising land, and assumed that immigration took place overland, as Mr. Forbes had done in the case of British vegetation; but he also found another powerful controlling agent, in alternating periods of greater moisture and comparative drought, of which the Norwegian bogs afford ample proof. The phenomena of distribution in the southern hemisphere are more difficult of explanation. The so-called Antarctic flora is now confined to the mountains and southern islands of the temperate zone, nowhere crosses the parallel of 62°, and is uniform around the globe. The temperate flora is fourfold, presenting more differences as between the three continents and New Zealand than do the floras of the northern continents. These plants have their representative species and genera on the mountains of the tropics, each in its own meridian only, and there meet immigrants from all latitudes of the northern hemisphere. No direct proof has been discovered that the southern plants originated in the south, but reasons exist for supposing that the southern flora came from the north temperate zone. Mr. Thistleton Dyer has maintained that the floras of all the countries of the globe may be traced back at some time of their history to the northern hemisphere, and that their present peculiarities in affinity and specialization are the natural results of the conditions to which they have been subjected during recent geological times, and supports his view with plausible arguments. A very similar view has been held and published by Count Saporta in his essay "L'ancienne Végétation polaire." Mr. Wallace independently advocates the view of the northern origin of the floras and faunas of the world in his "Island Life." The later works on geographical distribution include Mr. Wallace's "Geographical Distribution of Animals," Professor A. de Candolle's "Géographie Botanique," Dr. Grisebach's "Die Végétation der Erde," and Mr. G. Bentham's addresses before the Linnæan Society in 1869, 1870, and 1872.

Indian Burial-Caves. — Dr. Edward Palmer, who has been working under the direction of the Peabody Museum of Archæology of Cambridge, Massachusetts, has explored several caverns in Southwestern Coahuila, Mexico, that were long ago used as burial-places by the Indians. These caves have been mentioned by a few writers, and stories have been told by people who visited them or heard of them, nearly half a century ago, of the immense number of mummified human bodies that they contained. Since then the caves have been worked for niter, and thousands of the mummies have been burned. Dr. Palmer has found a considerable number of the bundles undisturbed, and has brought them to Cambridge. Each bundle contains the bones of one or more human skeletons and ornaments, implements, small baskets, articles of clothing, and other objects. The resemblance of the mummies with those found in the caves of Kentucky and Tennessee is of particular interest. Among numerous objects of art from the collection which Dr. Palmer exhibited at one of the meetings of the Boston Society of Natural History were parts of a fringed skirt, on the edge of which feathers had been fastened; a feather headdress, braided sandals, and pieces of finely and evenly woven cloth in different-colored patterns. Many of the things are not like those used by the Indians of the present day; and not a thing derived from Europeans has been found, so far as can be learned, in any of the caves. Dr. Palmer therefore thinks that the bodies were placed where they were found long before the Spanish conquest of the country.

Hope for Sufferers by Heart-Disease. — According to Dr. J. Milner Fothergill, the views of the medical profession as to the prospects for the future of cases of valvular disease of the heart are undergoing very considerable changes, in a direction opposite to the hopelessness with which they have been regarded in the past. Not every murmur which may be heard over the

heart is a sign that the patient is destined to a sudden death from the action of the cause that produces the sound, nor is it always evidence of organic cardiac disease. It is a grave symptom, but its importance may be and often is exaggerated. It is only probably produced by deformity in the cardiac valves; but anæmic, aortic, and, still more, pulmonary murmurs, are now generally recognized. The late Dr. Latham carefully discriminated between grave and comparatively trivial injuries to the mitral-valve curtains by endocarditis, and held that there were three divisions of cases of permanent unsoundness of the heart remaining after endocarditis: 1. Cases in which, besides the permanent endocardial murmur, there is no other symptom referable to the heart; 2. Cases in which, besides the murmur, there is occasional palpitation; and, 3. Cases in which, besides the murmur, there is constant palpitation. The typical cases of the text-books, where there is a series of morbid sequelæ gradually descending more or less swiftly, all belong to the third division. Dr. Fothergill has cases in his own practice of mitral murmurs which have existed for sixteen, fourteen, twenty-seven, and thirty-eight years, without developing any very alarming symptoms, and reports the death, between the writing and publication of his article, of a case of aortal regurgitation—a rapidly fatal form of disease—which had not perceptibly advanced during twenty-five years of excessive activity. He also notices cases of aortic obstruction of fourteen, sixteen, and eleven years, of which the first only has as yet died. In conclusion, he observes that under proper treatment, by which the prospects are profoundly affected, and with care, a life of activity is practicable in many cases, provided bodily exertion be avoided, or exercised moderately.

Recent German Archæological Discoveries.—Dr. Mehlis read a paper before the recent Congress of German Archæologists upon the human skeleton that has been found at Kirchheim, on the Eck. The skeleton lay in a north-and-south direction, with a polished stone hatchet on its breast, and around it were quite handsomely adorned potteries and broken bones of the musk-ox, aurochs, cow, dog, wild-boar, and sheep. The bones indicated a man of middling vigor, the skull approached in build the Engis and Niederingelheim skulls, and was strongly dolichocephalous, prognathous, and furnished with powerful jaw-bones. Dr. Vater described an interesting collection of objects which had been found early in August in digging for the foundations of a military building at Spandau. While digging in the moor at the entrance of the Havel into the Spree, the workmen came upon a pile-dwelling in which were bones of animals with a small, roundish skull of a high type, and bronzes in good condition: three swords, six celts, a knife, five lance-points, a ball of sandstone, several bits of horn, a grinding-stone, and a canoe ten feet long dug out from an oak-log. The metallic objects are much rusted, and of a northern type in form. The swords are distinguished by their typically short hilts. Dr. Gross exhibited a number of articles that he had dug from the mud of the Bieler Lake at Corcelette, among which were bronzes which had evidently been made on the spot, armlets, finger-rings, buttons, celts, molds for casting, a rude copper axe, horn lance-points, and a veritable lump of tin. Some of the earthen vessels represent pleasing types recalling Grecian patterns; others, dishes, have been painted in yellow, red, and white designs, and others bear a wave-ornament that appears to have been laid on with tin, in the same way that many of the lower Italian vials are adorned with stripes of gold. The latest excavations of Gross show that wood, horn, clay, iron, copper, tin, bronze, and amber, were used as materials, while gold and silver were still wanting. The marks of the use of the wheel in making the potteries indicate that a tolerably high state of civilization had been reached at this period, which, by all the evidence, must be fixed at a time before the Romans.

Prevention of Damp in Buildings.—M. G. Phillippe, civil engineer of Rouen, France, has considered the subject of damp in buildings, in papers that are reviewed in "Van Nostrand's Engineering Magazine." Damp is caused in buildings by the presence of water in the atmosphere and the soil, combined with the porosity of building mate-

rials, which absorb it. Its effects are to cause disintegration of masonry, the decay of timber, the development of saltpeter on walls, and injury to the health of the inhabitants of the buildings, with damage to the decorations of the walls and to furniture. Remedies to prevent and cure it may be applied to both the causes by: 1. Employing suitable materials for cellars and other parts of buildings below or on the level of the soil; 2. Inserting damp-courses to stop the upward progress of damp; 3. Applying preparations to protect the face of the exposed wall from the weather, or to prevent damp in the wall from affecting an apartment; and, 4. Adopting precautions against infiltration. Concrete, covering the whole ground-area of the future building with a layer four inches thick, forms the most thoroughly sanitary foundation. Well-puddled clay is also good and inexpensive, but is not effective in old buildings. The porosity of materials has been obviated by injecting them with gas-refuse, by immersing or washing them in solutions of soap and alum successively, by plunging them into a solution of silicate of potash, and by painting them with gas-tar. Mortars are made impervious by mixing them with cement. Parquets may be preserved by laying them upon bitumen. Ventilating bricks, which are made in France twice as large as common bricks, admit air to the interior of walls, and thus keep them dry. Under the Joumet patent, ventilable and perfectly dry floors and areas are made by laying the cement around pipes, which, being drawn out, leave the foundation penetrated by tubes. Conduits are made with the glyco-metallic liquid, or with gutta-percha. The stone settings of windows should be made moisture-proof, and leaden gutters on the inside, to catch the moisture that drips from the glass, will be of service. Slates should be hung on the Fourgeau or Chevreau hooks, with which the damp-admitting holes required when nails are used can be dispensed with. Finally, drains from closets should be furnished with ventilating pipes.

Are Marriage and the Family in Danger?—Certain magazinists, croaking preachers, and foreigners who look at American society through telescopes leveled at Utah and Chicago, have sounded a cry of alarm that the marriage institution and the purity of the family are decaying in the United States. Their assertions are founded on the frequency with which divorces are sought in some places where the process is made particularly easy. Granting that divorces are too freely given, and that the appetency for divorce indicates that something is wrong in the morals of the parties: have the alarmists ever stopped to inquire what are the moral characters of the parties aside from the fact of the divorce suit, or whether their morals would probably be any better if there were no possibility of divorce? And have they ever reflected upon the preponderating numbers of American married people who never think of applying for divorce, but are striving with all their might to build up and maintain a pure and healthful family life, and would continue to do so even if it were as easy to get a divorce as to buy a pair of boots? The very facts the alarmists cite show that there is no relation whatever between facility of divorce and moral laxity. In Maine, divorce is of the easiest—the court grants it at its discretion—yet no man in his senses will say that society in Maine is a whit less pure than in New York, where divorce is of the hardest to get. South Carolina allows no divorces, while North Carolina has a divorce law that is singularly lax, yet no difference can be perceived in the morality of the two States. Boston, where divorces are quite numerous, is quite as moral, to say the least, as Paris, where no divorce is allowed. An increase in the number of divorces is not observed in the United States only, but is receiving attention in countries where laxity can not be predicated of the laws. It is the case "enormously," according to the confession of the "Pall Mall Gazette," in England. In France, legal separations have gone up from 1 to 370 marriages in 1840–'50, to 1 in 152 in 1860–'70. In Belgium the ratio of divorces has risen from 1 in 576 couples in 1840, to 1 in 200 in 1874.

Biology in Public Schools.—Mr. George W. Peckham, of the Milwaukee (Wisconsin) High School, has told how he has succeeded in teaching biology to his classes of boys and girls. Two years' experience convinced

him that imparting the power "of repeating classifications of animals with all the appropriate definitions" had nothing to do with communicating genuine knowledge. He prepared a series of laboratory notes sufficient for the dissection of a few plants and animals, and used Huxley and Martin's text-book, after it was published, as a laboratory guide. The school board provided eight Beck's students' microscopes, and, he says, "we begin with the study of the torula; we then take in succession the following organisms: protococcus, amœba, bacteria, mold, stone-work, ferns, flowering plants, infusorian fresh-water polyp, clam, lobster, and frog. We devote to laboratory one hour daily for seven months. At the end of the course come morphological and physiological generalizations. Our classes number about eighty, and are divided into working sections of sixteen each. The average age of the students is sixteen years, rather more than half of them being girls. I have found the students eager and enthusiastic, and the large majority of them regret the untimely end of their study of biology," which is limited by the procrustean regulations of the school-course.

Nature of Diphtheria-Poison.—Drs. H. C. Wood and Henry Formad, co-operating with the National Board of Health, have been studying the nature of the diphtheritic contagium. They began with inoculating rabbits, under the skin or in muscles, with diphtheritic membranes taken from the throats of patients in Philadelphia. Not diphtheria but tuberculosis followed as an indirect and not a direct result of the inoculation, the relations between the two diseases seeming to be only apparent. When the false membrane was inserted into the tracheas of the rabbits, severe trachitis was produced, with an abundant formation of false membrane, identical with that of diphtheria. It was shown by further experiments that the production of false membrane involves nothing specific, but that any trachitis of sufficient severity is accompanied by it. The product differs from that of true diphtheria only in its containing fewer micrococci. Diphtheritic poison was next obtained from Ludington, Michigan, where a severe epidemic was raging. Inoculations with this matter, whether made under the skin, in the muscles, or in the trachea, were all followed by similar results, namely, a quick affection, a rapid spread of the local symptoms, and death; and the blood, examined during life or after death, was found to contain micrococci precisely similar to those found in the Ludington cases; and in a few instances the plants were found in the internal organs and the bone-marrow. The urine of patients suffering from malignant diphtheria is full of micrococci, and is even more deadly in its effects than the membrane. When cultivated, micrococci from Ludington grew rapidly up to the tenth generation, and those from Philadelphia ceased their growth in the fourth or fifth generation, while those taken from a furred tongue, which showed similar shapes, never got beyond the third transplantation. The conclusion was drawn that the micrococci found in ordinary sore-throat and those of diphtheria differ only in their reproductive activity. When rabbits were inoculated with cultivated micrococci, diphtheria was produced with the second generation, but never with any later product. Diphtheria may be self-generated whenever conditions arise within the body or act upon it from without competent to stimulate the inert micrococci in the mouth into active ones.

Scientific and Popular Experiments in Pathology.—Mr. John Simon, D. C. L., LL. D., in his address before a section of the International Medical Association, on "State Medicine," has forcibly presented the duty of the state to facilitate and encourage scientific researches into the causes of disease. All that we know or can know on this subject, he maintains, is and must be learned by experiment. The experiments that give us the teaching we seek are of two kinds: scientific experiments, carefully prearranged and comparatively few, performed in pathological laboratories, and for the most part on other animals than man; and "the experiments which accident does for us, and, above all, the incalculably large amount of crude experiment which is popularly done by man on man under our present ordinary conditions of social life." Thus, in regard to Asiatic cholera, we have the scientific infection experiments of Professor Thiersch

and others, performed on a few mice; and, on the other hand, the popular experiments which were performed on a half-million of human beings in London during the cholera epidemics of 1848–'49 and 1853–'54 by the water companies. M. Villemin has gained information of incalculable value concerning the causes and nature of tubercle from his laboratory experiments on other animals than man, and has been followed by others who have developed and extended his discoveries. Professor Gerlach, of Hanover, has in a similar manner studied the transmissibility of tubercle from animals to man by eating their flesh and drinking their milk. The popular experiments, performed by milk-dealers serving their customers, which lead us to suspect that tuberculosis might be transmissible through milk, are performed daily upon thousands of human beings. "The scientific experiments which have made us certain of the fact were conclusive when they amounted to half a dozen. Thus, without making any account of the relative value of human beings and animals, the scientific experiments are vastly more economical than the popular. They have the further advantage of being precise and exact, while the popular experiments very often have in them sources of ambiguity which lessen their usefulness for teaching." The principal problems to be solved in preventive medicine are how, by cross-breeding or otherwise, to convert a short-lived or constitutionally enfeebled stock into a long-lived or vigorous one, which has hardly yet become a practical question; and how to avoid or resist the extensive interferences which shorten life, on which much has been learned by vivisection, and more remains to be learned. Of the investigations in the latter line which have led to results of momentous value are cited the diversified researches of Pasteur and others on germs, and their specific applications to the diseases of domestic animals and man; Drs. Klebs and Tommasi Crudelli's examinations into the intimate cause of marsh-malaria; Dr. Grawitz's studies of the conversion of ordinarily harmless microphytes into agents of deadly infectiveness; Dr. Lister's application of Pasteur's discoveries to the antiseptic treatment of wounds; Professor Semmer and Dr. Krajewski's discovery of inoculation against septicæmia; and Dr. Schüller's contributions to the treatment of tubercular and scrofulous affections, on the basis of their microphytic origin. No work has been performed of more promise to the world than these various contributions to the knowledge of disease, its cure and prevention; and they are contributions which from the nature of the case have come, and could only have come, from the performance of experiments on living animals.

A Dangerous Tendency in Science.—Mr. W. Spottiswoode, in his president's address before the Royal Society, has sounded the note of alarm against an evil that has begun to affect science, and may result in harm if it grows. Research, he suggests, is being drawn into the hurry that characterizes other departments of life in our generation, and the glamour of sensational fame is too apt to blind the eye to the light of the solid honor which is the real and best reward of science. "Apart from other reasons, the difficulty, already great and always rapidly increasing, of ascertaining what is actually new in natural science; the liability at any moment of being anticipated by others, constantly present to the minds of those to whom priority is of serious importance; the desire to achieve something striking, either in principle or in mere illustration—all tend to disturb the even flow of scientific research. And it is, perhaps, not too much to say that an eagerness to outstrip others rather than to advance knowledge, and a struggle for relative rather than absolute progress, are among the most dangerous tendencies peculiar to the period in which we live." Happily, this tendency has not yet become general in science, and Mr. Spottiswoode's calling attention to it may go far toward providing a cure for it.

The Supposed Volcanoes in Central Asia.—The existence of volcanoes in Central Asia was formerly generally recognized on the authority of Humboldt. As the vast regions included in that country have become more accessible to Europeans, many of the supposed volcanoes have been proved to have no real existence, and the investigations of Russian explorers have resulted in showing that what in many in-

stances were regarded as volcanoes were merely extensive fires of stone-coal. Muschketoff maintained, in 1876, that there was no recent volcano in the country except, perhaps, Mount Baishan. Two years later General Kolpakoffsky endeavored to solve the question relative to that mountain, but his expedition failed to reach it. Last year he had better success, and a dispatch was read from him at the meeting of the Russian Geographical Society, on October 29th, stating that he had found the apparent volcanic phenomena there also to be caused by a stone-coal fire, that had been burning so long a time that no one could tell when it had begun. Opposite to Baishan is Mount Kiuntag, where the fire has ceased. The slopes of Baishan are marked with holes from which smoke and sulphurous gases stream out, and the fire in the interior is attended with a great noise. The question of the existence of volcanoes in Central Asia appears to be decided in the negative by this report, which also strengthens the theory that the action of volcanoes is chiefly due to water; for the supposed volcanoes in the interior of Asia, now known not to exist, afforded the only exceptions to the rule that all volcanoes are situated near large masses of water.

Reversion of Domesticated Animals to the Wild State.—The Hon. J. D. Caton has been taking some notes, during a sojourn in the Sandwich Islands, on the tendency of domesticated animals, when left to go wild, to revert to the habits, forms, and colors of their wild ancestors. "With the exception of the goose and the duck, nearly all the animals which have been introduced into the islands, as well as those which were then held in domestication, have reverted to the wild state. Among them are the ox, the horse, the goat, the sheep, the hog, the dog, the cat, the turkey, the peacock, and the barn-yard fowl. The greatest physical degeneracy was observed in the wild horse and the wild sheep. The latter are small, gaunt, and long-legged, with a scant and coarse pelage. The ox, in about seventy-five years, while it has not changed much in color and form, has become wild and wary, and very fleet in running over the lava in the mountainous regions which it selects as its home. The wild goats are very numerous, cautious, and difficult to approach, and are mostly white, but some are party-colored. The hog in a single generation "changes in form, color, and habit, from the staid and quiet porker to the fleet and fierce wild boar"; and one imported boar is told of that changed immediately after escaping from a ranch, and became as wild and fleet almost as a deer, with a thin body and arched back, and legs that appeared to be much longer, while he more slowly assumed the dark, sandy color of the wild boar. Turkeys also began quickly to take on the color and shape of the wild turkey. Wild barn-yard fowls fifty years after escaping, occupying an extensive elevated or mountainous wooded country, are the most wild and wary animals in the district, have a faculty of disappearing without noise at daylight, after having made the forest vocal with the crowing of the cocks, and have diminished in size, and become of a uniform buff-color. Judge Caton announces his conclusion in the "American Naturalist," in which his notes are published, that the tendency common to most animals to return to the wild habit, the form, and the coloring of the original species, is possibly strongest in those cases where the animal has been most recently reclaimed from the wild state, or where the change produced by domestication has been most rapid.

Safety on Suburban Railroads.—Two recent railway accidents have forcibly directed attention to the necessity of providing more efficient means of protecting passengers who have to travel on lines whose trains run with excessive frequency, as on the suburban railways of large cities. A train on one of the London railways and a train on the Hudson River Railroad were stopped casually—the first in a tunnel, the other at the end of a curved cut. The signals failed to be given to following trains, which came along in less than five minutes. In both cases hind cars were destroyed, and several persons were killed, and others—sixty in the London accident—hurt. The blame in both cases is attached to the signals or the signal-men. No system of signals can be devised that will be infallible, but those we have can be made better and

the method of using them may be vastly improved. The frequency of trains can not be diminished, but will have to be increased as the number of suburbans who do business in the cities increases. The only certain means of obtaining greater security seems to lie in increasing the number of ways out of the city; and, as there is a limit to the number of new railroads that can be built in such places, the way out may at last have to be sought in introducing steam tramways and steam-carriages on common roads. The London "Spectator" says that the present prohibition of these two forms of locomotion is "so absolute and so unreasoning as to operate as a direct check upon invention."

Spontaneous Combustion of Coal.—Seventy cases of spontaneous combustion of coal are recorded as having taken place among 31,116 ships in 1874. The combustion may go on so slowly that the rise of temperature will amount to only a few degrees, and probably always occurs where coal is heaped up in large quantities. Mr. W. Mattieu Williams has been led to the conclusion, by experiments in distilling inflammable hydrocarbon from cannel-slack, that it takes place in some degree in all cases where coal is exposed to the atmosphere. The yield of gas, which was at first good, continuously diminished, and at last became ruinously small, the slack at the bottom of the heaps being little better than coke. Soon after this, the railway to the colliery siding took fire under the rails from the oxidation and heating of the slack with which it was ballasted. The loss from this oxidation is greater in fine coal than when the mineral is in large lumps, because a greater proportion of surface is exposed. The liability to slow combustion varies with the quality of the coal, and is greatest in "brassy" coal, or coal that contains pyrites.

Egyptian Marriage and Animal-Worship.—M. Revillout has been struck, in examining some ancient Egyptian marriage settlements, with the predominance which was given to the wife in the family. In a deed of the time of Ptolemy Philadelphus, the groom, describing himself as the son of Pchelkons, "whose mother is Tahret," saith unto the woman Tarreteus, daughter of Relon, whose mother is Tarreteus, "I have accepted thee as my wife," and afterward, "I will establish thee as my wife." The preliminary "acceptance" mentioned here was a marriage for a year of probation, like the "hand-fasting" for a year, with power at the end of the year to break the contract, that used to prevail among the Highlanders of Scotland, and analogies to which may be found among some other people. An important point to be noted in the deed is the naming of the mothers of both contracting parties as a fact which, in itself, demonstrates the importance of the woman in the family, and as a survival of the time when family names were derived, not from the father, but from the mother. After accepting and establishing the woman as his wife, the man, among other things, promised to pay certain damages if he should take another wife, and gave the woman a kind of mortgage on all his property. Thus, in another deed, one Petoupra assigned to his wife, Neshorpchrat, "not only his house and all his landed property, present and future, but likewise his silver and copper money, his title-deeds and documents concerning his property. . . . He leaves himself absolutely nothing"; and the only clause in his favor was, that his wife should provide for him while he lived, and pay for his funeral liturgies, and for embalming his body when he died. This is not a singular instance. The Egyptian bridegroom, moreover, took his wife's name, and the sons, instead of being called after their fathers, were designated by the names of their mothers. A writer in the "Saturday Review" regards this custom, in connection with animal-worship, as originating in the same principle. The worship of animals, while nearly universal as a whole, was local as to each sacred animal. An animal that was worshiped in one place was hunted down in another, all over the country. These animals were probably originally selected and made peculiar to distinguish the families and stocks of the people, like the *totems* of our Indians, and the corresponding customs among the Australians and some African races. "There is scarcely a quarter of the globe where the tribes of contemporary savages are not divided into stocks, each of which, like the Egyptians, reveres a sacred animal or plant,

from which, like the Egyptian towns, it is named, and (as the Egyptians did) it refuses to eat that animal or plant. Further—and this is the essential point of our explanation—among the tribes which act thus, the mother is the permanent element in the family, and the children (as the Egyptians did) derive their names, not from the father, but from the mother's family." Among most of the purest races the various stocks which worship the different animals are scattered through all the local tribes. But in China, the worshipers of each animal, or at least the people who derive their name from him, are gathered together, as in Egypt, into local aggregates. Thus, the Egyptian marriage customs and the Egyptian animal-worship both seem susceptible of explanation as relics of savagery preserved into the midst of civilization by the extraordinary tenacity of Egyptian conservatism.

A Glossary of Microbes.—Mr. W. Hamlet gives the following classification of the microbes (microscopic organisms of fermentation and disease): 1. Microbes which appear as points are called *monads*, *monera*, or *micrococci*. They are motionless, and may be regarded as the spores of other microbes. 2. Motionless linear microbes—the *Bacteridians* and the *bacilli*. To them belongs *Bacillus anthracis*. 3. Cylindrical mobile microbes, having rounded ends or contracted in the middle so as to form an 8, are the *bacteria* proper. Among them is *Bacterium termo* of putrefaction, the commonest of all. 4. Flexuous mobile microbes. They look and act like eels, and differ but little from the equally active bacteria. They are the *vibrios*. 5. Spiral microbes, resembling a cork-screw, and mobile; *Spirilla spirochetæ*. Their presence in human blood appears to be connected with intermittent fever. 6. Microbes with heads, very active, having globules larger and more refractive than the rest of the body at one or both ends. These globules are apparently spores ready to be detached from a bacterium—*Bacterium capitatum*. Besides these six principal states, the microbes form agglomerations or colonies that often notably change the aspect of the elementary cells, and which have received various names. Agglomerations in microscopic masses, surrounded by a jelly that sticks them together and deprives them of motion, are called *zoöglœa*. A non-gelatinous membrane formed of motionless bacteria is a *mycoderma*. Bacteria attached end to end in a string form filaments of *leptothrix*. A number of spherical micrococci joined one after another form the string of round grains called a *torula*. A considerable number of species may be included in each of these divisions; and there does not appear at present any way to distinguish by sight a disease-producing bacterium from a harmless one.

Circulation of Blood in the Brain.—Signor Mosso, who has been engaged on the subject for six years, has published some new observations on the different conditions of the circulation of the blood in the brain. He has had the privilege of observing three patients who had holes in their skulls, permitting the examination of the encephalic movements and circulation. No part of the body exhibits a pulsation as varied in its form as the brain. The pulsation may be described as tricuspid; that is, it consists of a strong beat, preceded and followed by lesser beats. It gathers strength when the brain is at work, corresponding with the more rapid flow of blood to the organ. The increase in the volume of the brain does not depend upon any change in the respiratory rhythm; for, if we take the pulse of the fore-arm simultaneously with that of the brain, we can not perceive that the cerebral labor exercises any influence upon the fore-arm, although the pulsation in the brain may be considerably modified. The emotions have a similar effect upon the circulation of the brain to that of cerebral labor. Signor Mosso has also observed and registered graphically the variations of the cerebral pulse during sleep. Generally the pulses of the wrist and the brain vary oppositely. At the moment of waking, the pulse of the wrist diminishes, while that of the brain increases. The cerebral pulsations diminish as the sleep grows deeper, and at last become very weak. Outward excitations determine the same modifications during sleep as in the waking state, without waking the sleeper. A deep inspiration always produces a diminution in the volume

of the brain, in consequence, probably, of the increased flow of blood into the veins of the thoracic cavity; the increase of volume in the brain, when it takes place, is, on the contrary, due to a more abundant flow of arterial blood to the encephalus.

NOTES.

ACCORDING to Professor Cope's "Review," members of the order of *Rodentia* were very abundant during the White River and Truckee (Miocene) epochs in North America. They are referable to thirty-one species and eight genera, of which three genera—*Sciurus*, *Hesperomys*, and *Lepus*—still exist in the regions where their fossil remains are found. All the species belong to the three great divisions of the order which now inhabit North America, while the fourth division, *Hystricomorpha*, now very sparingly represented on the continent, has not been detected in the formations in question, but appears in a single species of porcupine in the Loup Fork bed. None of the species are of larger size than their modern representatives, while the beavers, squirrels, and rabbits are smaller.

M. DE QUATREFAGES has called attention to a story told in the "Histoire de la Louisiane" by M. Le Page du Pratz, of a Yazoo Indian named Moncatch Apé, who, before the year 1720, made a journey to the upper Missouri, thence over to the head-waters of the Columbia, in regions then wholly unknown to white men. Reaching a tribe of the Pacific coast, he learned that the Indians were visited regularly every year by white men with long, black beards, who came in fleets of thirty pirogues or more. They were described as stout and short, with large heads covered with cloth, their coats coming down to the middle of their legs, which, with their feet, were covered with a red or yellow dress. Their arms made a great noise and a great fire. M. de Quatrefages believes that those visitors may be identified with the Loo-Choo Islanders.

PROFESSOR RILEY has described a new imported insect which has been found preying upon the clover-fields at Barrington, New York. Its damages were first observed in the latter part of April, when small patches of clover showed the leaves to be badly eaten, and increased till the end of July, when acres of the clover were ruined. The insect continued to lay its eggs till October, a part of them outside the plant, but most of them inside of the old and hollow stems. The insect is a beetle, known as the *Phytonomus punctatus*.

GOVERNOR JOHN POPE HENNESSY, of Hong-Kong, gives a good account of the success which has attended the faithful practice of vaccination among the Chinese of that colony and the neighboring mainland. No port in the world is more liable to a visitation of small-pox; yet the disease never spreads at Hong-Kong. The health-officer of the colony, noticing that nearly all the young Chinese emigrants had vaccination or inoculation-marks on their arms, learned on inquiry that the doctors of the Tung-wa Hospital—a native charitable institution—practice vaccination upon their countrymen in the colony, and send travelling vaccinators over the adjoining provinces of China, using lymph supplied them by the British Colonial Office.

MR. M. E. WADSWORTH, in a communication to the Boston Society of Natural History, has given his reasons for believing that the iron-ores of the Marquette district, Lake Superior, are of eruptive, and not of sedimentary origin, as has been commonly held. He rests his conclusions upon the fact that the jaspilite and iron-ore in this district, while they offer no characters inconsistent with those which known eruptive rocks have, "possess characters which eruptive rocks exhibit, especially in relation to other rocks, and which no sedimentary rock, proved to be such, has been known to have." The particular facts supporting this view are given in the paper.

MR. P. HOGLAN has made experiments toward ascertaining whether calomel is liable to decomposition in the human system, with the production of corrosive sublimate. He has found that calomel may be slowly decomposed and corrosive sublimate formed by the action of water at the temperature of the body, and that the change is accelerated by the presence of citric acid, sodium chloride, or sugar.

THE geological formations of Schuylkill County, Pennsylvania, embrace, according to Mr. P. W. Sheafer's monograph on the subject, the rocks, with an exception or two, from the Oneida conglomerate (Upper Silurian) to the coal-measures. The only formation of importance for its mineral wealth is the last. It rests upon the Pottsville conglomerate (Millstone Grit), which has served as a barrier to protect the coal-deposits from erosion, and which varies in thickness from 675 to 1,030 feet. The coal-bearing strata are 3,000 feet thick at their thickest point, and include, perhaps, thirty coal-beds, of which fifteen are workable and over three feet thick, giving a total of 107 feet of coal. The series can be separated into three divisions by the color of the ash of the coals: a lower or white-ash group, a middle or gray-ash group, and an upper or red-ash group,

with a still lower red-ash group in the conglomerate.

M. ALFRED GAUTHIER, for many years Professor of Astronomy at Geneva, died December 2d, in the ninetieth year of his age.

AN English engineer, who bought a boiler sixteen years old, and used it as if its capacity to resist pressure was equal to that of a new and perfectly sound one, till it blew up and caused the death of several workmen, has been sentenced by the court at Leeds to a year's imprisonment for criminal negligence. The "Pall Mall Gazette" declares that the sentence is "severe, as it is probably novel," but can not consider it in excess of the merits.

So far as the Department of Agriculture has been able to obtain information on the subject, 181,583 acres of land in the United States are devoted to the culture of the grape, giving a production of 23,453,827 gallons of wine, of an estimated value of $13,426,174. California leads in respect to both the area planted and the quantity of production, while the industry is not so concentrated anywhere east of the Rocky Mountains as in that State. Yet, while California produces three or four million gallons more than all the other States, the value of the crops of the latter is, in consequence of their greater accessibility to the market, more than twice as great as that of the crop of California.

RECOGNIZING that the zero of thermometers is moved after undergoing sudden changes of temperature, and that it gradually rises during the first few months after the instruments are made, M. Pernet has inquired whether the distance between the "boiling-point" and the "freezing-point" is likewise subject to variations or is constant at all different stages of secular alteration in volume of bulbs. He has found that the distance is constant if the freezing-point is determined immediately after the boiling-point; but that if the boiling-point be determined and a long interval elapse before the freezing-point is determined, there is a considerable error. For a thermometer to read rightly at any particular temperature, it should be exposed for a considerable time to the temperature for which exact measure is desired, or else for a few minutes to a slightly higher temperature.

MR. LAWRENCE BRUNER, of West Point, Nebraska, who has been traveling in the locust-centers of the West and Northwest, with especial reference to investigating the probabilities for another visitation of the pests, reports that there are probably no locust-eggs east of the Rocky Mountains this season, and that, therefore, a general visitation in 1882 is highly improbable.

DR. AMI BOUÉ, who recently died at Vienna, at the advanced age of eighty-seven years, is stated to have been the author of more than two hundred works on subjects related to geology and natural history. He had been for more than fifty years an honorary member of the Geological Society of London, and received the Wollaston Medal in 1847.

THE Nickajack Cave, near the corner of Tennessee, Georgia, and Alabama, which is comparable in dimensions with the Mammoth and Wyandotte Caves, contains like them a fauna with peculiar characteristics. Professor Cope, who recently made two collecting expeditions into it, found abundant traces of human habitation near its mouth: first of the outer world so far within as light from without could be observed; and, farther in, blind crawfish, whose snowy-white forms could be readily distinguished by candle-light in the clear water. Of the five kinds of animals living in the waters of the cave, all but one differ decidedly from those of the caves of Kentucky, Indiana, and Virginia. This indicates, Professor Cope suggests, that these cave-forms are the descendants of different out-of-door species from those of the more northern caves.

PROFESSOR W. K. BROOKS, Ph. D., of Johns Hopkins University, has been awarded a medal of the first class by the Société d'Acclimation of Paris, for his work on the "Development of the Oyster." Professor H. A. Rowland, of the same institution, has been awarded the prize of 1,500 lire which was offered by the Reale Instituto Veneto di Scienze, Lettere ed Arti, for the best essay on the "Mechanical Equivalent of Heat." The essay has been translated into Italian, and will be published by the institute.

PROFESSOR E. D. COPE has described a new saurian (*Champsosauris Australis*), belonging to a genus of uncertain affinity, that has hitherto been regarded as peculiar to the Laramie strata, which is found in New Mexico, in a formation lying below the typical Wahsatch Eocene. Specimens of the genus appear also to have been found by Dr. Lemoine near Reims, in France, in the Suessonian Eocene, associated with mammalia.

M. RENÉ THURY, of Geneva, has communicated some observations on the production of inductive currents by distant lightning. He stretched between the roofs of two houses a wire, one end of which communicated with the ground, while the other end was connected with a telephone. Whenever lightning was perceived at a distance that might reach as far as twenty-five miles, the telephone simultaneously uttered a characteristic sound.

PROFESSOR LOUIS PASTEUR.